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Construction of a Big Plant

GENERAL ARRANGEMENT AND SOME SPECIAL CONSTRUCTION FEATURES OF THE ESSEX PLANT OF THE PUBLIC SERVICE ELECTRIC CO. OF NEW JERSEY

STUDYING THE GROWTH of its business and the load on the stations at that time available, the engineers of the Public Service Electric Co. decided that the Marion Station, completed in 1913, would shortly be insufficient for the load. In the system of the Public Service Electric Co., of New Jersey, the various plants are tied together to care for railway, light and power loads in the northeastern part of New Jersey extending from Asbury Park and Bound Brook to Paterson and Jersey City.

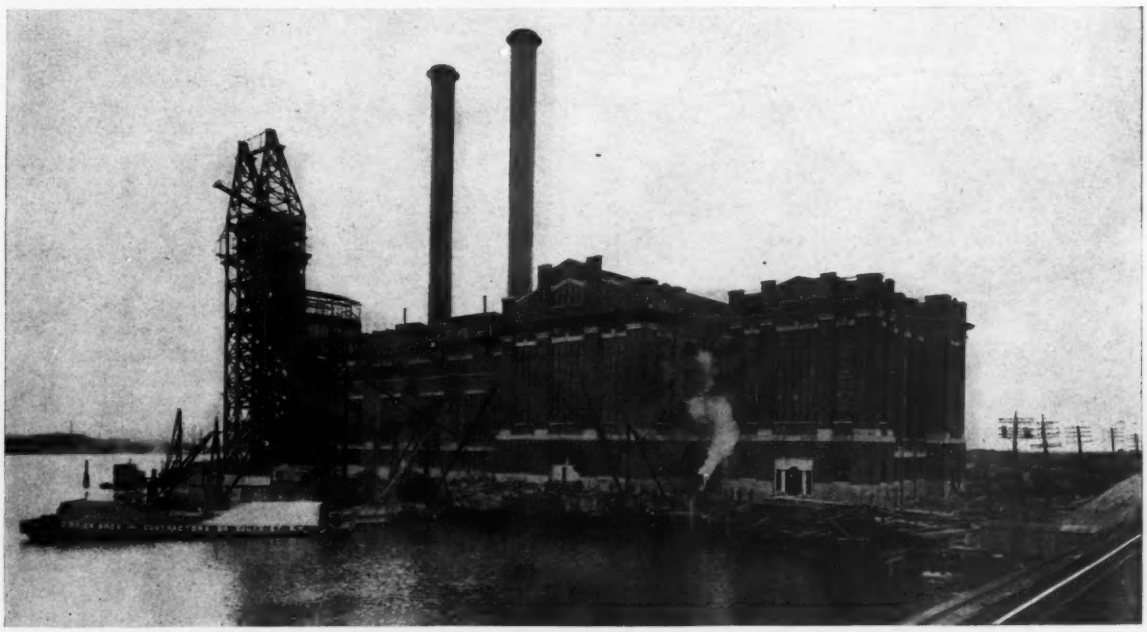


FIG. 23. VIEW OF ESSEX PLANT FROM RIVER SIDE

LOCATION

IN DETERMINING the location of the Essex plant, consideration was given to the distribution of the load and to the methods of securing coal for operating the plant as well as for a plentiful supply of circulating water. The Essex Station, located at Point-No-Point on the Passaic River is 2½ miles from the Newark station, and about the same distance from the Marion station, and adjoins the tracks of the Pennsylvania Railroad and is also near a spur track connecting to other roads by transfer tracks of the New York Bay Railroad and the Central Railroad of New Jersey Manufacturers' Extension. Coal can, therefore, be readily obtained, either by rail or by water, and the Passaic River furnishes a plentiful supply of circulating water, but as it is salt water is not available for boiler feed.

PRESENT INSTALLATION

IN GENERAL the plan is for parallel buildings for the boiler house, turbine house and switch house, with a coal bunker located alongside the boiler house and a coal track extending to a storage yard at the side and rear.

The ultimate capacity of the installation will be 200,000 kv.a., the first installation which is now completed and has for some months been in operation consisting of one-sixth the boiler capacity, 4 boilers, and one-quarter of the turbine capacity, 2 turbines, to house this equipment, and to provide room for future equipment without extending the buildings, one-third of the boiler house, one-half the turbine house and one-half the switch house have been built. The second one-third of the boiler house has now been started and the foundations are well advanced. Also the second battery of 4 boilers is in process of erection and will be completed before the end of the current year.

The present boiler building is 166 ft. deep, 116 ft. wide and 106 ft. high to the top of the monitor. The turbine room is 167 ft. deep, 90 ft. wide and 113 ft.

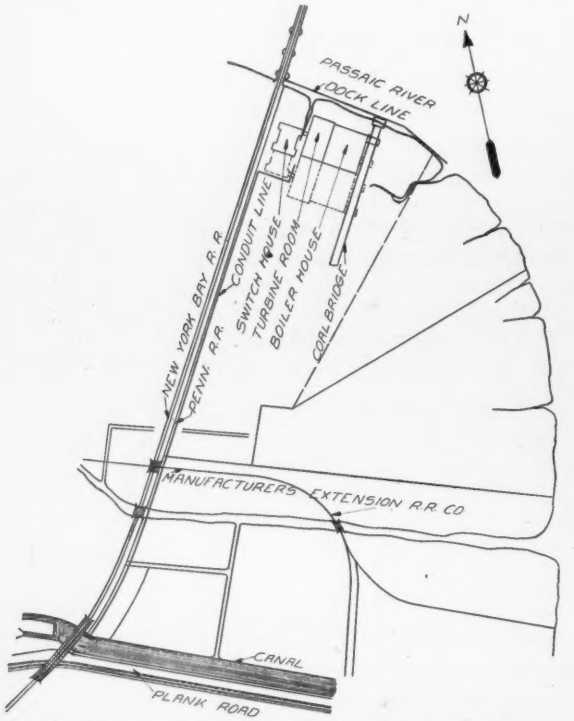


FIG. 1. ARRANGEMENT AND SURROUNDINGS OF POINT-NO-POINT STATION

high, and the switch house 117 ft. deep, 70 ft. wide and 95 ft. high. Figure 1 gives an idea of the arrangement of the site, showing the location of the present and future buildings and the service for coal handling machinery given by the railroads and the river.

The Start of Construction

As approached in July, 1914, the place where the station was to be erected did not seem promising. A mud flat covered with reeds and water, low lying by the side of the river, and with muddy creeks where in high water times the drainage flows down, did not seem a good foundation on which to erect an immense building and framework to carry enormously heavy machinery. But the engineers taking this into account, had made full plans as to how the location was to be transformed.

At the start, piling had to be driven at frequent intervals until the piles came to a solid bearing. Then these must be smoothed off and a concrete floor built in over the entire area to carry the load of the superstructure and to bind together the mass of piling which transmitted the weight to the firm strata below. The first work was done in the latter part of July, 1914, the initial operation being shown in Fig. 2, the driving of the first piles to get ready for a coffer dam to bar out the river water from the area to be covered with piling. This first work of pile driving for the coffer dam was done from a floating pile driver, and, like all the foundation work, was carried on by the Linde & Griffith Co.

Piles used on the whole job were driven to a depth of 35 ft., and those under the building foundation were

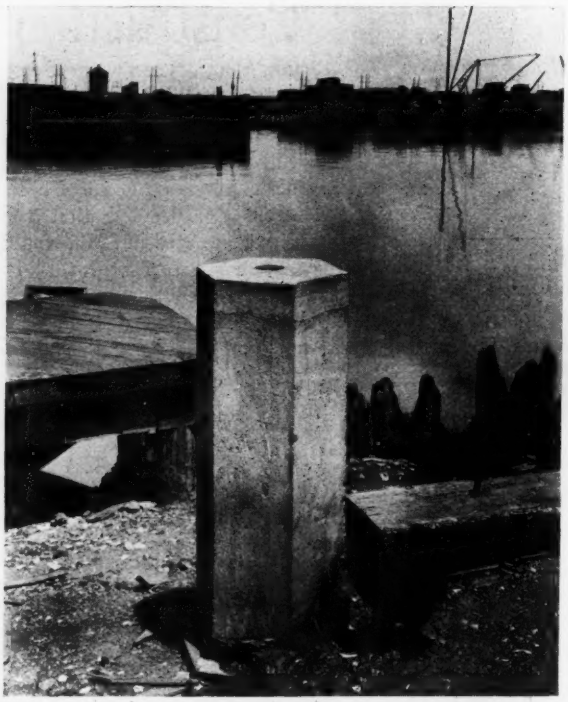
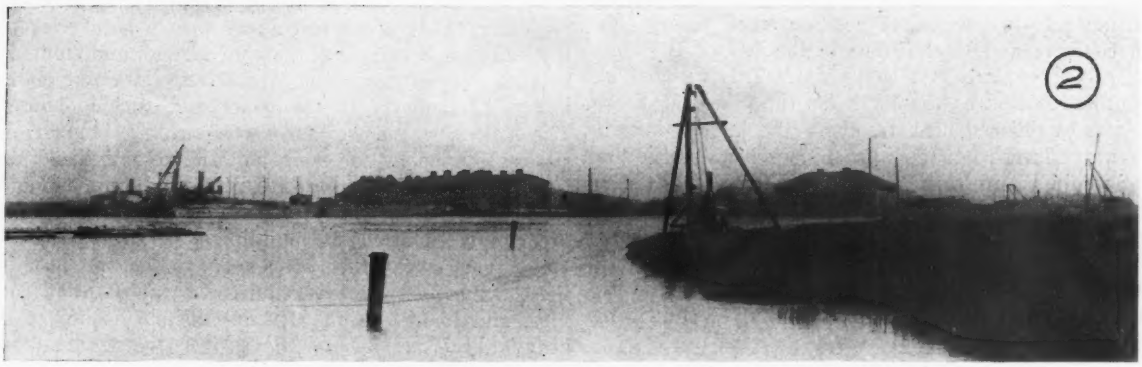


FIG. 4. THE STARTING POINT FOR HEIGHTS

placed 2 ft. 6 in. centers. Along the water front the piles were practically the same spacing and served to carry a sheathing which was also cross braced by planking and braced from inside by diagonal timbers. After the establishment of the coffer dam, portable pile drivers on timber platforms were installed and the process of piling the entire foundation area was carried through, the water being pumped out inside the coffer dam and soft mud excavated to the depth where the concrete platform was to rest. Figure 3 shows the progress of the work in October, the construction of the coffer dam and the various drivers at work on the inside area.

Locating Levels

After progress had been made in driving piles to the point where it was necessary to level off the pile tops and prepare for the concrete work, it became essential to establish some point from which levels could be



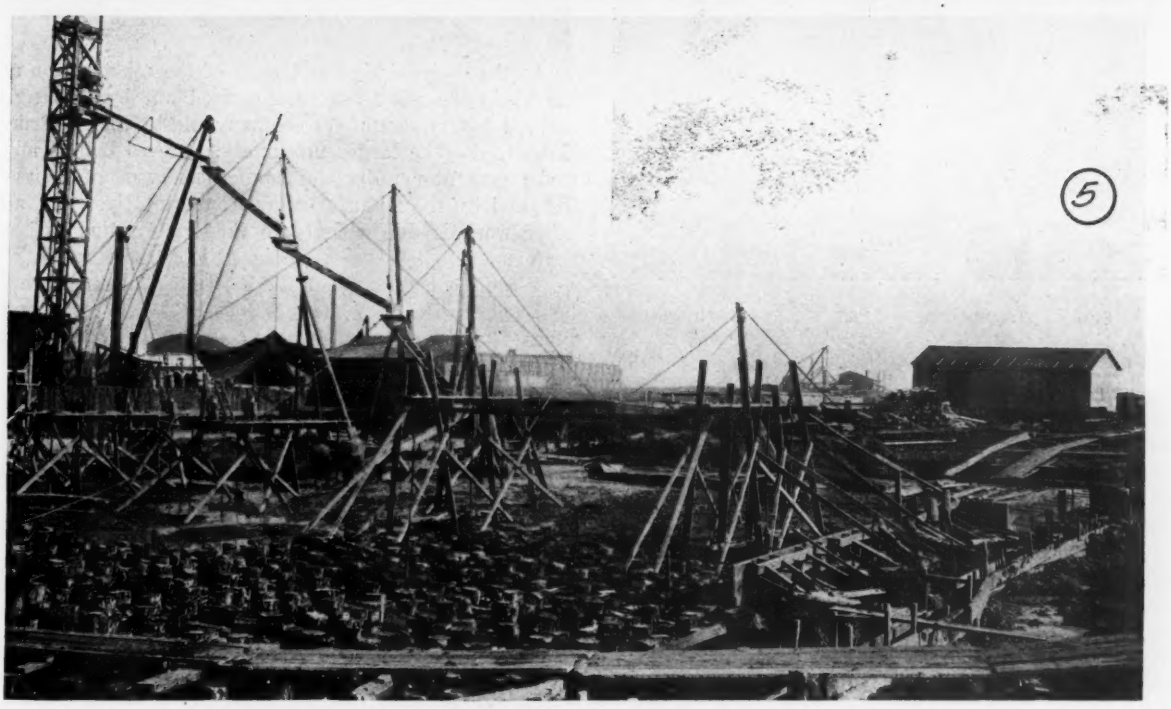


FIG. 2. THE START OF THE ESSEX PLANT CONSTRUCTION FIG. 3. PILE DRIVERS AT WORK ON THE DOCK FRONTAGE
FIG. 5. LEVELED PILES READY FOR CONCRETE

measured, and this was accomplished by the driving of a datum pile to permanent position, then casing this with concrete and establishing in the top of the concrete a copper plate as a base point. This was put at level 100, which was the level for the basement floor, and was established at 1 ft. above the highest known high water level so that all machinery installed in the plant would be protected from any danger of flooding. At this location there is wide area for the spreading out of any flood waters so that a high flood, such as might be encountered in a hilly country would be entirely impossible. Figure 4 shows the datum for levels, and also a platform erected for locating a transit in establishing the level at other points in the work.

After piles had been driven to a solid bearing they were leveled off at 10 and 12 ft. below the 100-ft. level,

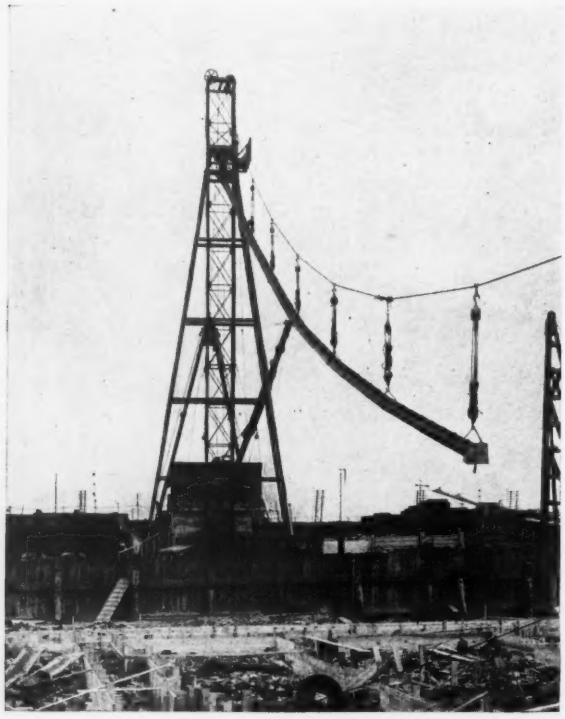


FIG. 6. TOWER FOR CONCRETE DISTRIBUTION

thus keeping them well below the water line so that they will at all times be submerged and thus avoid the deterioration encountered where piles are alternately wet and dry. Upon the piles a solid concrete slab from 3 to 5 ft. thick was laid, covering to 1 ft. below the tops of the pile heads and upon this slab the column foundations were erected by means of forms.

In putting down this concrete work the mixers were kept at one or two central locations and the mixture distributed by means of elevators to towers and inclined troughs and telphers to the desired points. The method of handling the work and the progress made up to November and December of 1914 is shown in Figs. 5 and 6. Figure 5 shows a tower and concrete distribution from a land mixer, and Fig. 6 a 90-ft. distributing tower located on a barge at the water side of the development.

Building Framing

The weight of all machinery was to be carried on the building framing by means of girders and columns, so that it was necessary to make the framing extra heavy, particularly in the boiler and turbine houses. The boilers, which are immense affairs, are slung from girders carried by the main building columns, and the turbines are carried on girders supported from columns running up to the first floor level. Also the chimneys are supported from the building structure above the boiler room level, which saves space in the first floor of the boiler house. All this requires very substantial footings, and it will be noted from the cut Fig. 7, that heavy I-beam reinforcement was introduced with cross grillage and wind bracing tied into the floor and foundation to insure rigidity and firmness throughout the steel frame structure. Figure 7 also shows the construction of the dock front, the arrangement of the heavy piling and planking and the back bracing with rip-rap and concrete backing behind the sheeting. Figure 8 was taken in February, 1915, and gives an idea of the boiler house foundation, the grillage work for the column footings, the weight of the main frame columns, and the wind bracing used to take any side strains.

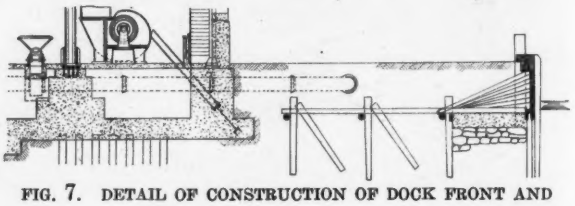


FIG. 7. DETAIL OF CONSTRUCTION OF DOCK FRONT AND FOUNDATION

In the entire design and most of the construction of the plant the work has been carried out by the engineering department of the company and by the construction force. The larger machinery, such as boilers and turbo generator units and condensers, was, of course, installed by the manufacturers' representatives, but all other work is due entirely to the organization of the company, and the success achieved is to their credit.

Weekly consultations of the heads of departments are held, where the progress of work is talked over and plans for new work discussed, also any hard problems encountered in work under way are taken up, and suggestions are made by all members of the organization. In this way the united skill and resourcefulness of the entire organization is made available on all parts of the work, the general direction being, of course, in charge of N. A. Carle, Chief Engineer of the company.

General Plan

As indicated in Fig. 1, the general plan provides for a coal tower east of the boiler house on the river bank which unloads from barges to the crusher located near the top of the tower. Coal is then taken by conveyors to the bunkers which run along the east side of the boiler house, or may be discharged through chutes into the storage yard at the east and south of the plant. Reclaiming of coal from the storage yard is accomplished by locomotive cranes and conveyors into a skip hoist

FIG. 8. BOILER HOUSE FOUNDATION AND STEEL WORK

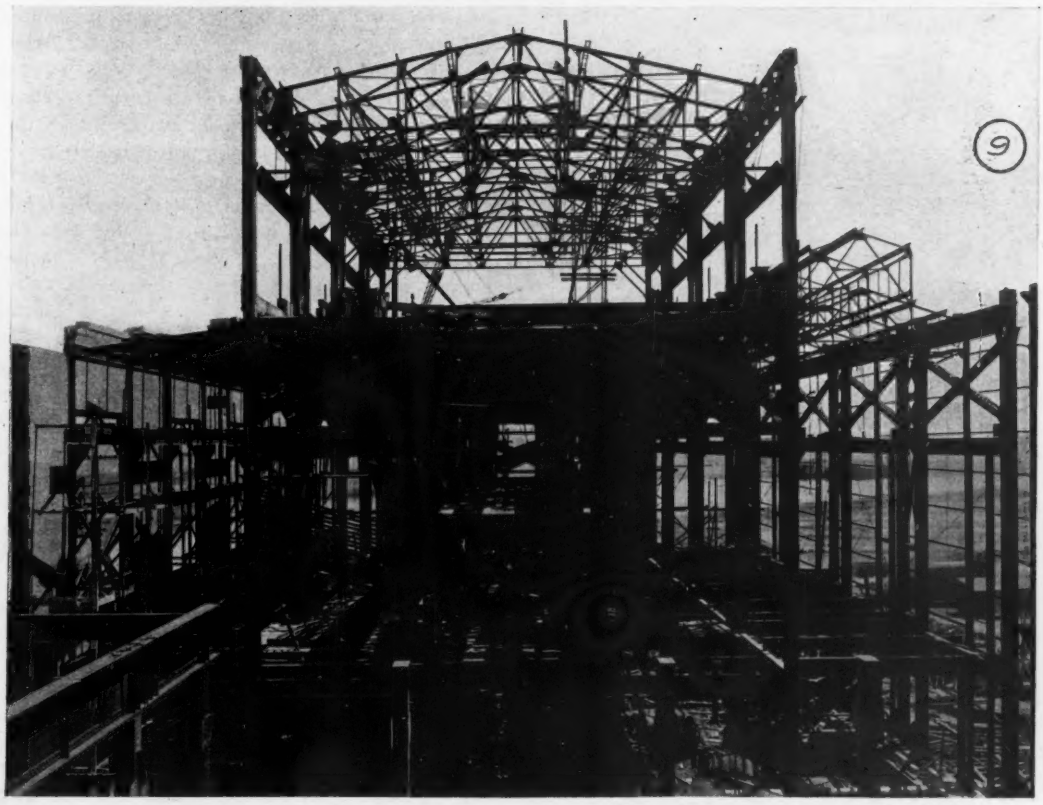


FIG. 9. BOILER HOUSE STEEL FRAMING

which delivers direct into the bunkers. From the bunkers coal is taken by traveling larries which run in the firing aisles between boilers, and is delivered after weighing to the stoker hoppers. The station is in general of the unit plan, although interconnected so that any combination may be made. A unit of 4 boilers, each of 1373 nominal rated horsepower, supplies steam to a 25,000-kv.a. turbo generator unit having a condenser located below it in the basement of the turbine house.

In the switch house to the west is installed the high tension equipment, storage batteries, control room and offices, each turbo generator unit being arranged to tie through its generator bus to any one of 6 group buses as may be required. Cooling water tunnels are carried

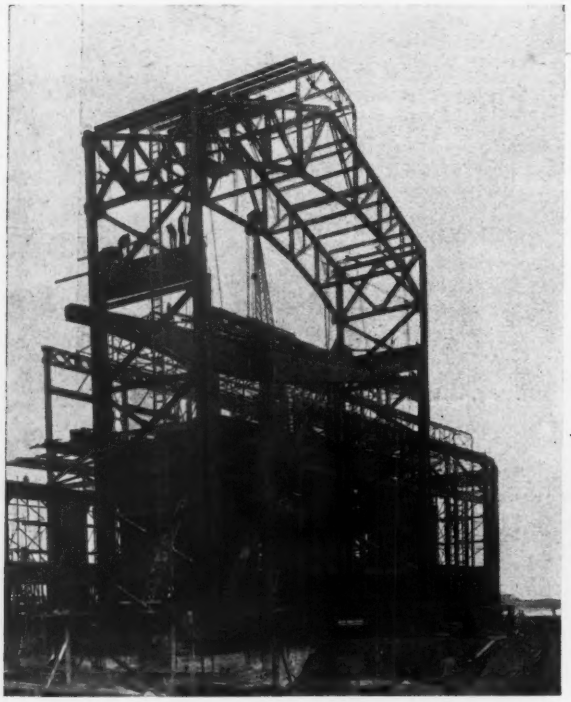


FIG. 10. FIRST ARCH OF TURBINE HOUSE FRAMING AND CRANE GIRDER

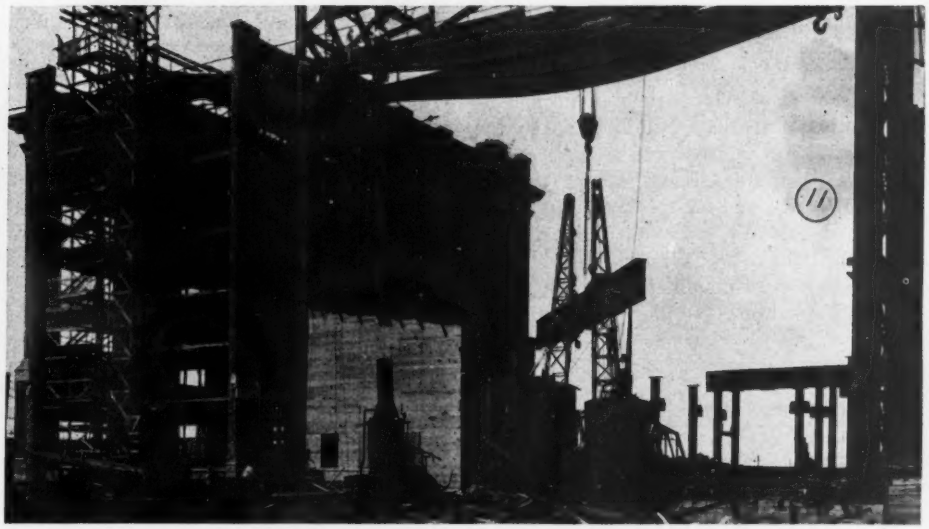
from the river front under the turbine house floor to the condensers and return, being built as tunnels in the concrete foundation. Pumps, blowers and ash-handling apparatus are installed in the basement of the boiler house; the heaters are on the boiler floor level between the 2 banks of boilers, metering tanks and testing apparatus are on the mezzanine floor opposite the top of the boilers, and the economizers and stack girders are on a floor above the boilers.

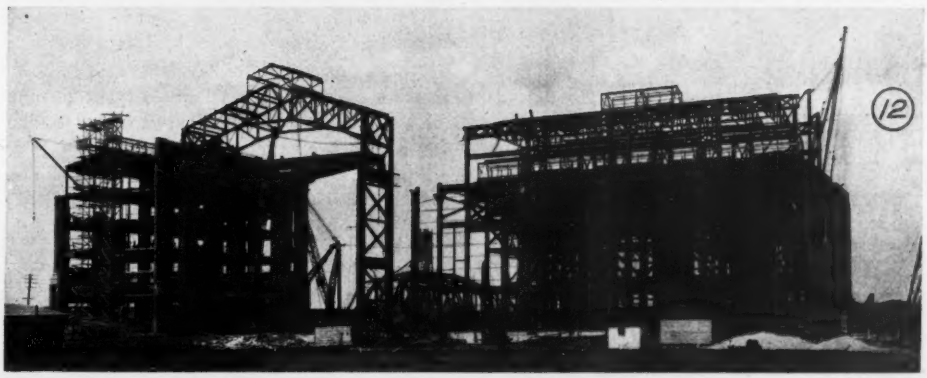
Progress Planning

In the construction plans for the plant the deliveries of the main units were scheduled as given by the manufacturers, and the building work was carried on accordingly to meet these deliveries. On account of the heavy parts to be handled it was desirable that the boiler units be installed at the same time that the framework was being erected and before the masonry walls were in place. For this reason the frame work of the boiler house was pushed to give the boiler installing force a chance to get at work early, but the walls were left until later. As the turbo generators, on account of the time required for manufacture, would be delivered much later than the boilers, the construction of the turbine house was allowed to lag behind that of the boiler and switch houses, the latter being pushed to permit of the work necessary in installing the wiring and bus bar connections and the switches. Also the switch house walls were carried along with the framing so that the building might be covered in and permit of the work of installing electrical apparatus which could not be exposed to the weather.

Figure 9 shows the progress made on the boiler house framing at the end of May, 1915, the heavy steel construction of the main bays and the beginning of the installation of the boilers. This view gives also a very good idea of the arrangement of the building. The lower side bays are firing aisles in which the larries for feeding the stoker hoppers are carried. Below the boiler floor level at the left is a mezzanine floor for toilets and shower baths, having steel lockers for the men, and on the basement level below is the switchboard for the boiler house electrical equipment. The left bay in the main structure has 4 boilers which were the first installation put in, and in the basement below the ash hoppers and car tracks for the ash-handling cars. The center bay has in the basement the pumps which draw their supply either from the heaters located in the center aisle at the boiler level or from a storage tank and tunnel in the basement floor. On the mezzanine floor in the center bay are located the metering tanks and on the upper floor of the main part of the house in the turrets are located the economizers, the induced draft fans and the lower part of the stack. The feed water regulators for automatic control of the boiler feed are located at the level of the steam drums on the mezzanine floor. This cut gives also a good idea of the heavy columns and girder framing in the main structure for carrying the weight of the boilers and economizers and in the lower left-hand corner is shown one of the heavy girders which serves as a foundation for the turbo generator units.

Erection of one span of the turbine house was made early in order that the crane might be raised in place and be available for handling the heavy parts of the generators which were to be wound on the job. Erection of the sides and roof truss was comparatively simple and was accomplished by the use of gin poles and tackle, but the crane girders must go up as a single piece, and the question arose how to do this quickly and effectively. It was finally accomplished as indicated in Fig. 10, by raising a gin pole of steel truss construction vertical and lashing the top end to the lower chord of the roof truss. Rope was then reeved through tackle blocks until a sufficient number of plies were secured to carry the weight of the crane girder and the end was run through a pulley at the ground and attached to a switching locomotive. The crane girder was then slung to the lower hooks of the tackle and the locomotive ran down the switch tracks, raising the girders steadily and rapidly into position in 4 minutes. The second





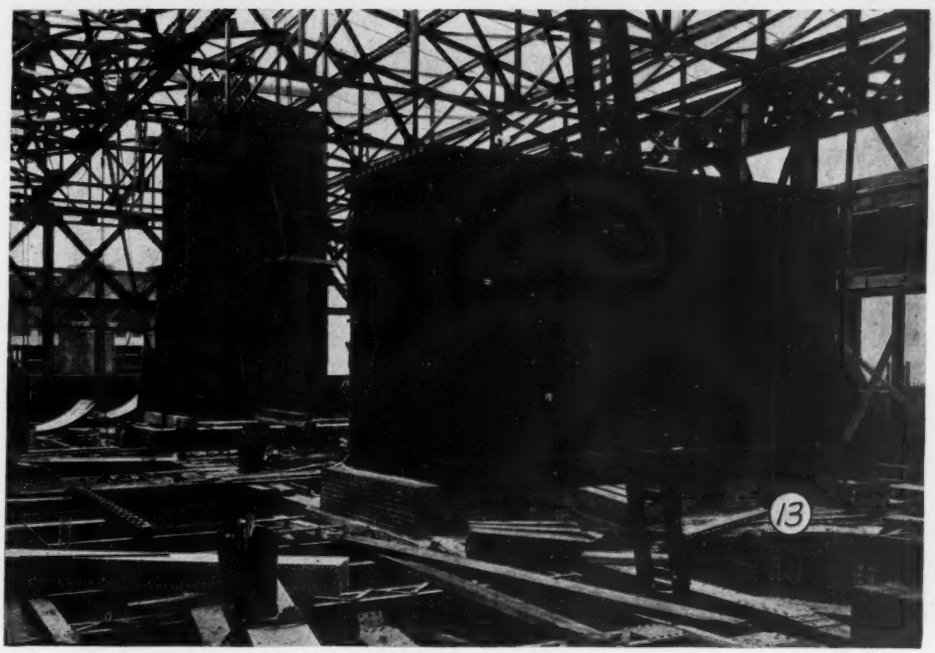


FIG. 11. RAISING TURBINE FOUNDATION GIRDER FIG. 12. PROGRESS OF BUILDING FRAMEWORK
FIG. 13. CONSTRUCTION OF STACK BASE AND ECONOMIZER

girder was likewise raised to position, the crane completed and locked in place on the single span for the use of the generator winders. Figure 10 also indicates the rather unusual construction of the turbine house which has a clear span of 90 ft., allowing plenty of room for working around the long turbine units and giving good ventilation and clear handling space for parts in case of repairs or overhauling. The crane is carried on girders on the side frames of the turbine house, has a span of 90 ft., and a capacity of 100 tons.

While this is a substantial capacity, a problem arose in connection with the handling of the heavy girders for the turbine foundation. Although the girder crane could hold these girders, it did not have the capacity

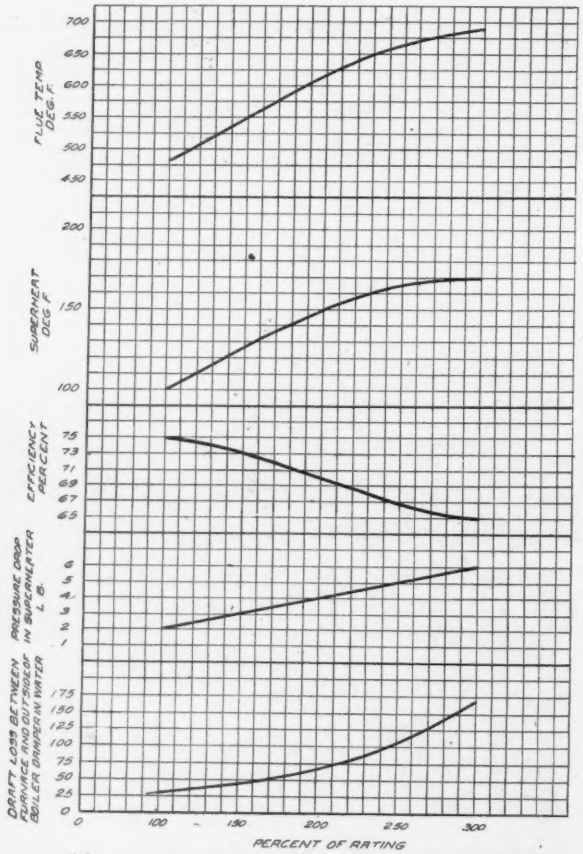


FIG. 14. CURVES OF ESTIMATED BOILER PERFORMANCE

to raise them, and the question was how to get them up to the level of the turbine room floor. The method adopted is shown in Fig. 11, where one of the girders is shown in position and another one in the process of being raised. Using 2 locomotive cranes, or ,"mud hens," it was possible to raise the girder up to a point above the necessary level and here it could be handled by the carriage of the girder frame and taken sideways to the proper position opposite the supporting columns. It was then lowered away and guided into position by pull ropes and the use of the locomotive crane. It was by such expedients as this that the work was facilitated and the erection of the buildings pushed forward with no delay and at a minimum of cost.

Figure 12, taken in June, 1915, shows the progress of the 3 buildings, the boiler house frame work being practically completed and the boilers under erection, and the east end wall being well along. The switch house is nearly completed, the walls being carried up with the frame work and the turbine house has the one span up for carrying the crane, and work is being carried forward on the rest of the framing and on the turbine foundations, while the winding of the generators is in process. This view also gives a good idea of the general arrangement of the buildings, and shows, at the rear of the space where the turbine house is to be erected, the bridge across the Passaic River which makes connection to the Pennsylvania tracks.

Another piece of erection work which was carried forward with the framing of the boiler house and before it was covered in was the placing of the economizers and the building of the stacks. These are carried on the floor above the boiler room, the bases of the stacks resting on a cylindrical girder construction carried by heavy columns and cross girders. The stacks are of the self-supporting steel type lined with radial stock brick and with the lower courses securely bolted to the girders. The stacks proper were built up course by course in place, as indicated in Fig. 13, which shows one stock in process of erection and one of the economizers resting on its brick sub-base. The circular girder construction for the other stack is shown in the lower right-hand corner.

Boiler Features

This Essex plant is of particular interest on account of the large size of the boilers, the great output planned for in the completed plant and the special provision for eliminating hand labor in the operation of the plant. Each boiler has 13,727 sq. ft. of heating surface, and is rated at 1373 horsepower. There is also 1711 sq. ft. of superheating surface, the boilers being designed to generate steam at 225 lb. pressure and 100 deg. superheat under normal rated load. The guarantee is the evaporation of 41,200 lb. of steam per hour from and at 212 deg., and that the boilers will run at 300 per cent rating with the heating surfaces clean and with ample stokers and draft capacity furnished. They are of the Babcock & Wilcox make, cross drum type, 42 tubes wide, 16 tubes high and the inclined tubes 18 ft. long of 9 gage. The steam drum is 60 in. diameter, 30 ft. 7 in. long, and of plates 7/8 in. thick, 2 sheets being used on each drum with the joints triple riveted butt straps. There are 2 rows of circulating tubes connecting the steam drums to the upper ends of the uptake headers. The upper row of circulating tubes which enters the steam drum at a slight angle is 15 ft. 3½ in. long, and the lower row which enters direct is 15 ft. 2⅝ in. long. Forged steel headers and mud drums are used, the latter being 7¼ in. square, made up in 2 parts, bolted together at the center, and each mud chamber having outlets for 3 blowoff connections. In each end of the steam drum is a manhole 12 by 16 in., and baffles are arranged in front of the upper tubes and below the steam dry pipes to prevent moisture from entering the steam nozzles. Feed water is taken in at each end of the steam drum and discharged through vertical nozzles and an umbrella hood. Shop tests were made on the sections for 500 lb.,

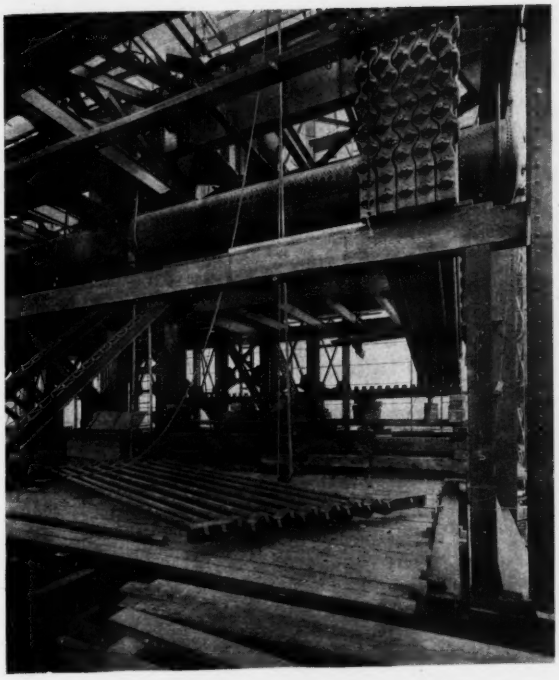


FIG. 15. STARTING THE ERECTION OF A BOILER

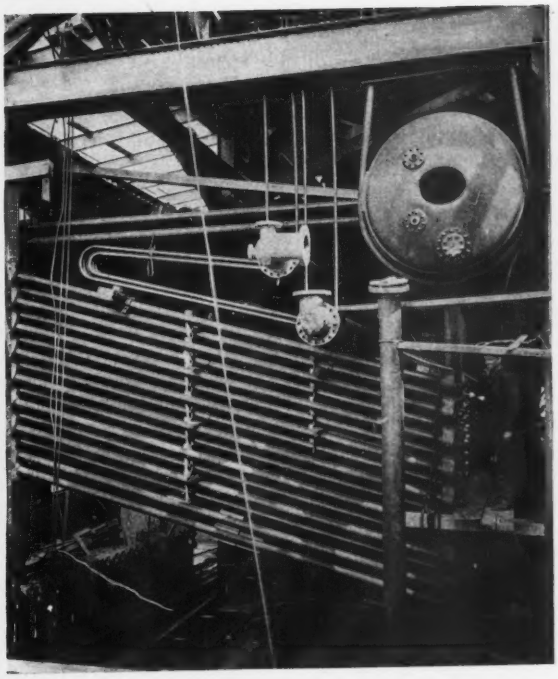


FIG. 17. SIDE OF BOILER AND SUPERHEATER DURING ERECTION

FIG. 16. REAR VIEW OF BOILER IN COURSE OF ERECTION

on the drums for 338 lb., and on the mud drums for 500 lb. pressure. The shipping weight of each boiler was 240,000 lb.

Curves of estimated performance were submitted with the specifications as shown in Fig. 14, and it will be noted that at normal rating the flue gas temperature is 480 deg., while at 300 per cent it is 690 deg. The draft loss through the boiler is 0.27 in. of water at rating, and 1.7 in. at 300 per cent. The superheat at normal rating is 100 deg., and at 300 per cent of rating 170 deg., and the pressure drop through the superheater is 2 lb. at normal rating and 6 lb. at 300 per cent rating. The efficiency curve shows that at normal rating 75 per cent will be realized and at 300 per cent rating 65 per cent. While this excess rating is not high as compared with performance in some other plants, it should be remembered that this is secured with a single end furnace, and the heating surface, 13,727 sq. ft. in each boiler, is believed to be the greatest ever embodied in a single end unit. Each steam drum is equipped with 6 Crosby 4½-in. safety valves, set in 3 pairs, and has 2 steam outlets, each 8 in. in diameter with a 15-in. flange. From these steam outlets the steam is taken by pipe bends without a valve to the superheater header and after passing through the superheater is delivered to the control valves on the connection to the steam main running to the turbine room. At the superheater outlet 2 4½-in. Crosby safety valves are mounted directly at the connection to the superheater. The blowoff outlets from the mud drum are 2½ in. diameter, each outlet being equipped with an Everlasting blowoff valve, and in series with these B. & W. blowoff valves, the outlets running to a blowoff line beneath the boiler room floor. Equipment provided with each boiler consists of an Ashcroft 12-in. dial gage, Babcock & Wilcox water columns, with Durabla gage glass, and Huyette gage cocks. The further equipment will be taken up in connection with the description of the complete steam plant later.

Erecting the Boilers

In the erection of these boilers, the drums were first slung by round straps at each end to the girders above, each sling strap carrying a weight of 100,000 lb. The mud drums were then blocked in place and sections put in position one at a time, each section being 16 tubes high and having the front and back headers attached to the tubes. These were lifted into place, blocked at the front end and later slung by a strap around the upper tube to the girder above. The back end rests upon the mud drum and is blocked high enough to permit inserting a 5-in. nipple which connects the lower end of the back header to the mud drum. These nipples were expanded into place and the top tubes running from the upper end of the front header to the steam drum were then put into position and expanded, the arrangement being shown on the cross-section view of the boiler and setting, Fig. 19. The downflow tube from the steam drum to the top end of the back header was also put into position and expanded in, the length of this tube being 3 ft. 4½ in. The appearance of the drums in position, the mud drums, and 5 tube sections is shown in Fig. 15, also one of the tube sections is shown here lying on the floor. The cut gives an excellent idea of the methods involved in erection and of the way the drums are suspended. The sections were spaced apart by wedging while the tubes were being expanded in and the weight was kept on the blocking until the expanding was completed. Figure 16 shows a rear view of a boiler with the sections all in position, the wedges still in place for holding the sections at the proper distance apart, and the men at work fitting the tube hole plates into the headers. Comparison of the height of the men with the height of the headers will also give an idea of the enormous size of these units. Also the cut illustrates well the heavy columns used to carry the weight of the boilers, and the heavy latticed wind bracing put in to stiffen the frame work. At the right upper corner of the boiler will be seen the suspending straps which carry the front ends of the sections.

Superheater headers were next slung in place to the girders above by means of round sling rods, and the bent tubes blocked in position and expanded into the superheater headers. During this time of expanding, these bent tubes were blocked from the boiler tubes below and also slung by rope slings to the tubes above, but when completed an angle iron was carried through the curve of the superheater tubes and slung by tie rods to the girders overhead. Figure 17 shows the superheater in process of erection and also the location of the baffle plate between the boiler tubes, the location of flanges for the water column connection, and the flange in the drum head where the feed water pipe enters. In this view the front end of the stoker carrying the bearings for the operating shaft is seen in the lower left-hand corner, also the dead plates are shown in the center below the boiler. Here also may be seen plainly the heavy sling rods which carry the steam drums and the weight of the back end of the boiler and also, in the upper left-hand corner, the slings which support the front ends of the sections. On the back sides of the superheater drums will be noticed a series of holes which, when the boiler is completed, are covered by plates. These are for cleaning out the superheater tubes, a hole being provided opposite each row of tubes.

Baffles between the boiler tubes consist of iron plates lined with fire brick, the lining in front of the first baffle, which is the long one seen in Fig. 17, being made double. The bricks seen on the lower rows of tubes in Fig. 17 are part of the tiles which form a roof between the front baffle and the top of the bridge wall, giving a partial tile roof to the furnace at this point. As shown in the cross-section drawing of the boiler and setting, Fig. 19, baffles are installed from the top row of horizontal tubes to the upper superheater drum and between the drums, to throw the gases downward around the rear baffle, and a blocking of fire brick is established around the top tubes running up to the roof of the boiler setting.

While the superheater was being installed, the spaces between headers were caulked with asbestos rope and the side and rear brick walls were built up, also the bridge wall.

Figure 18 shows the front view of the boilers nearly completed with the 2 swinging and 2 sliding front doors, the stoker hoppers and driving shaft and the white

(Continued on page 757)

Oil Fuel--IV.

FORCED DRAFT—BLOWERS. BY ERNEST H. PEABODY

WHILE excellent natural draft results may be obtained with oil—both with steam and mechanical atomizers—the high boiler capacities which may be developed with this fuel require high forced draft.

Where high boiler capacity is not needed, but where natural draft conditions are not quite sufficient, the burners and air-controlling devices may be housed in, and air under moderate pressure delivered into this casing, either by individual fans or by ducts. Figure 7 illustrates an arrangement of this kind used for Scotch boilers. It is also applicable, with slight changes, to water-tube boilers.

The standard Howden heated-air system, which is so useful for Scotch boiler installations, is easily applied to use with oil fuel. Also owing to the relatively low uptake temperatures with oil as compared with coal, the so-called "induced-draft system" is especially suitable—

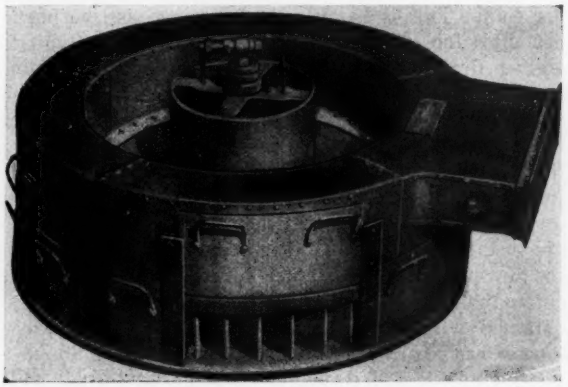


FIG. 7. WHITE FORCED DRAFT HOUSING FOR SCOTCH BOILER FURNACE

particularly with boilers similar to the B. & W., in which the gases leave the boiler at temperatures so low as to make the use of air heaters or economizers in the uptake hardly of sufficient value to cover the cost of installation. Induced draft has all the convenience of natural draft in the matter of handling the burners.

FURNACE DESIGN

IN MANY RESPECTS the water-tube-boiler furnace is better adapted for oil burning than the Scotch-boiler furnace; thus the larger amount of incandescent brickwork is an aid to combustion and the size and form of the furnace may be proportioned to promote still further the burning of the oil.

It has long been recognized that the type of burner, while important, is of less significance than the size and general design of the furnace. In those cases, now becoming rare, where the oil is atomized to the point of giving "flameless combustion," furnace design does not require so much care; but where a flame exists, it must be prevented from localizing on the boiler surfaces and the gases must be kept highly heated and given time and space in which to burn as completely as possible before being brought into contact with the boiler. Air admission and control are of prime importance, and the round-flame mechanical atomizer particularly requires special means for mixing thoroughly and evenly the minimum amount of air with the oil spray; also, as the gases expand and burn they require more room.

The best furnace conditions for burning oil are well represented in the furnace of the Babcock & Wilcox marine boiler, a section view of which is given herewith.

The reverberatory brick baffle on the bottom group of tubes directs the gases to the rear of the furnace, in which direction it will be noted that the furnace increases in height and volume. Furthermore, the oil is injected into the furnace along lines nearly parallel or at a slight angle with the tubes, which promotes an even distribution of the flame along the bottom row of tubes.

The importance of the principles involved in this design are further emphasized by the fact that an adaptation of them is used by The Babcock & Wilcox

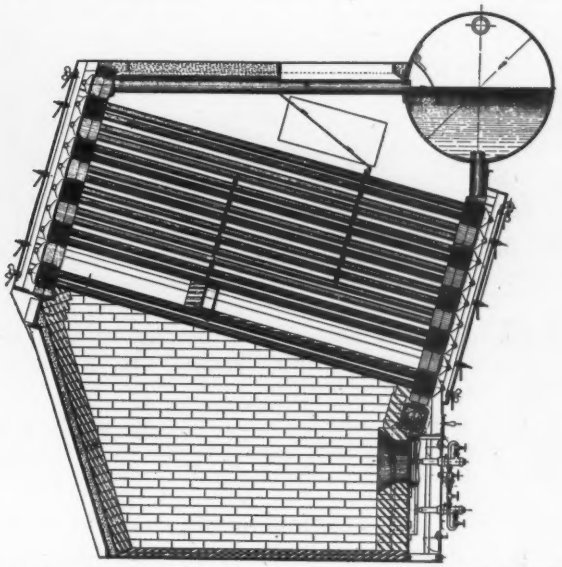


FIG. 8. FURNACE OF BABCOCK & WILCOX MARINE BOILER

Co. in their standard oil-burning furnace for the stationary or land-type of boiler. This is shown in Fig. 9, reproduced from the patent drawing, and it will be noticed that the burner tip is located at the small end of the furnace, which thus increases in height and volume in the direction in which the oil is injected. This is the first application of what has come to be known as the "rear-shot burner," a device which has been imitated many times owing to the high results in capacity and economy obtained with this furnace arrangement.

The furnace brickwork in water-tube marine boilers must be constructed of the best material obtainable, owing to the high temperature in the furnace. In Scotch boilers, less care in selecting the brick is permissible, as the brickwork usually installed is limited

to the front of the corrugated furnace, which remains comparatively cool, and to a small patch of flooring in the furnace under the oil spray to catch drippings and assist in igniting the oil, and to a ring of brickwork at the throat of the furnace at the combustion chamber end and to the back of the combustion chamber itself. At the 3 points last named the brick is prevented from becoming excessively hot by contact with the water-cooled surface of the boiler. The water-tube-boiler furnace has no such protection for the bricks, the brickwork being a protection for the casing. Thus, these brick must stand the high temperature of the furnace of this character of boiler, which may reach 2800 to over 3000 deg. F.

The Babcock & Wilcox Co. uses a light wash for making joints, composed of 15 parts (by weight) of fire clay, 5 parts of carborundum sand, and 1 part silicate of soda. The special high-temperature cements on the market are a needless expense for new work but are effective for repairs, where they find a special field of usefulness.

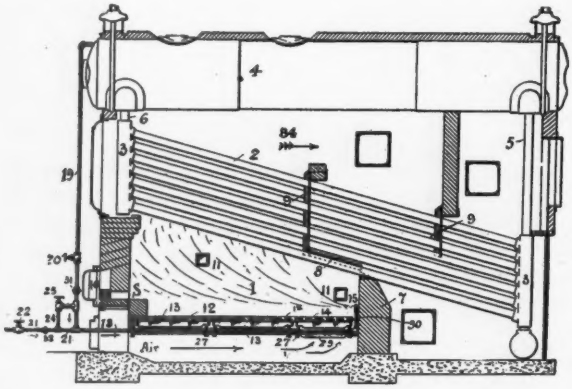


FIG. 9. STANDARD BABCOCK & WILCOX OIL FURNACE FOR STATIONARY BOILERS

It is a good idea to throw a few old glass bottles into the furnace to make a glaze on the bottom surface and fill the cracks.

Furnace Volume

In the burning of oil, "furnace volume" has the same significance that "grate surface" possesses in coal-burning installations. Strictly speaking, "effective furnace volume," or that actually occupied by the burning gases, is the volume which should be considered. This is somewhat indeterminate, however, and the proportion of the full volume actually utilized varies in different types of boilers. It is customary, therefore, to base calculations on the total volume of the combustion chamber, making an allowance where data are available for special furnace designs in which more or less of the total volume is utilized. In the Scotch boiler furnace, little attention is paid to volume: first, because the boilers are not forced to the same extent as are water-tube boilers, and second, because usually one burner is installed per furnace and the proportions are more or less left to take care of themselves—large-diameter furnaces generally being preferred, especially for forced draft.

In water-tube boilers conditions are different. Almost without exception the burners all discharge into a common combustion chamber, and conditions are at once encountered which do not enter into the problem of the "one-burner-one-furnace" arrangement of the Scotch boiler. Thus, there may be interference between the flames from adjacent burners, and undoubtedly eddies of gas occur in the furnace which affect air admission and control, although not wholly indicated by the draft gage. For instance, in a furnace fitted with, say 4 burners, properly spaced and provided with proper means for air control, each burner being surrounded by a fixed area for air admission, and having a furnace volume equivalent to, say, 60 cu. ft. per burner and operating at a fixed draft of, say, ½ in. at the damper, a certain maximum boiler capacity is obtainable when operating all 4 burners. This cannot be increased 25 per cent by installing a fifth burner of the same size and with like air opening. In fact, under the particular conditions named, while there will be some increase, the actual gain in boiler capacity will be little, although the burner oil-atomizing capacity and the area for the intake of air for combustion have been increased 25 per cent. This is because the oil which can be burned per cubic foot of furnace volume has a certain limit for a given draft and cannot be increased beyond that limit by the further multiplication of burners, even when accompanied by increased opening in the boiler front for air admission. The draft gage does not explain this, as the draft is kept constant at the damper and the furnace draft will be reduced but slightly on the firing up of the fifth burner. On the other hand, if 3 burners are installed instead of 4, keeping the size the same and the air openings the same per burner, the boiler capacity obtainable will be much more than ¾ of that previously obtained with the 4-burner equipment; for here each burner has a furnace volume allotted to it of 80 cu. ft. instead of 60, and it will be found that the oil which can be burned per burner will be materially increased and there will be a tendency to approach the same rate of combustion of oil per cubic foot of furnace as before.

The actual limit in the rate of combustion of oil per cubic foot of furnace is apparently a matter of heat units rather than pounds of oil; or to put it another way, the boiler capacity obtainable under given conditions of burner equipment, furnace volume and draft, seems to be more or less independent of the quality of oil, that is, more oil of poor quality can be burned without smoke than of the richer oil. The total number of heat units evolved, however, in a given time is approximately constant. The net result is that just as high boiler capacity can be obtained with a given draft with good oil and bad oil. I am not ready to say that this will not have decided limitations, but the indication is that larger furnaces will not be required for poor oil.

Air for Combustion—Uptake Area

The air required for complete combustion varies with the composition of the oil. Approximately, however, it may be considered about 14 lb. of air per pound of oil or about 183 cu. ft. at 60 deg. F.

The nature of the fuel and methods of burning it permit the excess air required for complete combustion in the furnace to be reduced greatly—tests having shown less than 10 per cent. This means that the air actually

required per pound of oil, under the best conditions, will equal about 200 cu. ft. at 60 deg. F. A liberal allowance over this figure should be made when figuring sizes of blowers, air ducts, etc., as test conditions cannot be maintained in practice.

The United States Navy has fixed the areas of funnels in recent installations as 1 sq. ft. for each 300 lb. of oil burned per hour. This proportion has been reduced to 1 sq. ft. for each 375 lb. of oil burned per hour in "destroyers," which have short uptakes and funnels. These areas, while adequate for naval vessels which operate at maximum power only under forced draft conditions, should not be taken as a criterion for merchant service. A safe rule would provide 1 sq. ft. cross-sectional area of funnels for each 200 lb. of the maximum amount of oil burned per hour.

Number of Burners per Boiler

The less the volume of combustion space provided per burner, the less the ultimate capacity per burner in pounds of oil burned under fixed conditions of draft. This falling off in maximum individual burner capacity as the number of burners per furnace is increased, is in less proportion, however, than the increase in the number of burners, assuming that the total furnace volume and the draft remain constant, so that up to a certain point the ultimate boiler capacity obtained with a fixed draft is increased by using a larger number of smaller size burners. The increments grow less and less, however, as the limit is approached in the rate at which the oil can be burned. This limit increases with the draft, and for approximate values, with a draft at the damper equal to ¼ in., the limit may be placed at about 5 lb. of oil per cubic foot of furnace volume per hour; and with forced draft equal to 5 in. of water, at about 15 lb. of oil per cubic foot of furnace volume per hour, assuming the oil to contain about 19,000 B.t.u. per lb.

A few years ago we fixed upon about 350 lb. of oil per burner per hour as the maximum individual burner output it was desirable to use, for the reason that the same intimate mixture of air with the oil spray could not be secured with the larger sizes. Thus the smaller size burners gave better efficiency. Tests, however, show that excellent gas analyses may be obtained when delivering upwards of 600 lb. of oil per burner per hour, and Messrs. Babcock & Wilcox, Limited, of England, with their own design of air control and a modification of the Peabody burner, have recently made some interesting tests, burning 880 lb. of oil per burner per hour. The boiler efficiency was in this case 73.4 per cent at the rate of evaporation of 16.15 lb. of water per hour per square foot of heating surface from and at 212 deg. F.

With a large number of small burners, a variable load is carried successfully and easily by shutting off and lighting up burners to meet the heavier fluctuation, while the oil pressure and temperature provide satisfactory regulation for slight variations. It is well known that the amount of oil (pounds per hour) sprayed by a mechanical atomizer varies directly as the pressure and inversely as the temperature. Below a certain "critical temperature," heating the oil increases the burner output, but ordinary working temperatures are usually above this point, so that heating the oil usually reduces the burner capacity.

Should a few large-capacity burners be installed, the flexibility to meet all load conditions decreases to some extent when using burners of the now popular fixed-orifice type. Possibly this may lead to wider use of burners of the adjustable or regulating type.

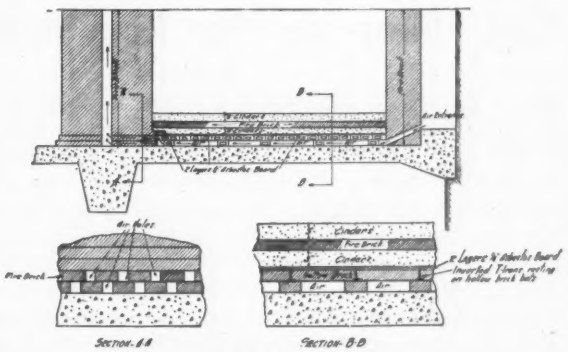
D. J. Irish has also proposed a burner which he calls the "high-low" type—that is, there is an adjustment which renders the burner capable either of delivering a high capacity or a low capacity. One adjustment only, eliminates to a considerable extent the liability of faulty setting of the completely adjustable burner, which in the hands of unskilled operators is one of the objections to the latter type.

The "high-low" burner has a special field also in those cases where the plant may operate alternately at forced or natural draft. It will also be useful for port use for Naval vessels, where it is now customary to use special tips, about half the standard size.

With the quick detachable couplings now generally used, it is, on the other hand, an easy matter to substitute a large burner for a small one and vice versa.

Insulation of Fire Boxes on Concrete Floors

TWO new boilers were installed on a reinforced concrete floor, and after being used for a short time cracks were noticed in the concrete. An examination showed that they were caused by the expansion of the concrete on account of excessive heat. A little later a brick wall which separated the 2 boilers had to be taken out because the heat was so intense that the wall started to give way. This wall was 34 in. thick, with



METHOD OF INSULATING FIRE BOX

outer layers of fire brick and the interior of common brick, and rested directly on the concrete floor. When this wall was torn out the concrete under the wall was found to have begun to dehydrate. On taking up some of the insulation under the fire boxes, which consisted of a 1-in. layer of 85 per cent magnesia over the concrete, 2 layers of common brick, and a top layer of fire brick, it was found that neither the common brick nor the fire brick were injured, but the magnesia had become pulverized and the concrete dehydrated on the surface.

Asked to suggest some method of overcoming the difficulty, The Ferro Concrete Construction Co. proposed

the method shown in the accompanying cross section. The method depends for its protection largely on the circulating air space between the fire boxes and the floor, and in the separating wall. Holes were punched through the outer wall to allow the outside air to enter, pass under each boiler and up through the slot in the center wall.

This air space under the fire boxes was formed by inverting steel tees 2½ by 2½ by 5/16 in., placed the length of a brick apart, these being held above the concrete by hollow brick bats placed under the tee sections approximately 2 ft. apart. The tees were covered by a layer of hollow brick, thus forming an air space above the brick. The entire surface of this brick was flushed with a sealing of clay, which was covered in turn by two layers of ¼-in. asbestos board. Over the board was placed a 3-in. fill of cinders, another layer of fire brick, and another 3-in. fill of cinders. This construction provided not only a circulating air space, but a dead space formed by the hollow brick. Particular care was taken that no air could get from this ventilating air-space through the insulation into the fire box.

Under the brick wall the air space was formed by placing the 2 lower layers of brick as shown in section AA, leaving an air space between each 2 bricks. When the wall itself was replaced it was built entirely of fire brick.

The boilers have now been in operation for some months, and no further trouble has been experienced. A vigorous current of outside air is constantly drawn through the air holes. The roof of the air space formed by the hollow brick is pretty hot, but the bottom formed by the concrete has a temperature of about 250 deg. F. (121 deg. C.), as measured by a pyrometer at various points. This temperature is not high enough to cause any damage to the concrete.

Two Motors on One Line Shaft

By C. V. Hull

IN A gas tractor plant where I was once employed, a 15-hp. 220-v. shunt-wound motor was used to drive a line shaft. Owing to a sudden demand for finished parts, it was decided to add several machines to the line shaft. This increased the load beyond the capacity of the motor.

As this load was to last but a short time, the superintendent objected to cutting the line shaft. He also refused to purchase a larger motor. As he was not an electrician, he suggested that another 15-hp. 220-v. shunt-wound motor which was in the store room be belted to the shaft also. Rather than argue with him, the electrician decided to try the plan.

The motors were belted up and handled a load which varied from 30 to 100 amp. in nice shape. This result was obtained by putting a rheostat in series with the field of the slow running motor. By adjusting the rheostat when the load was heavy, very fair results were obtained.

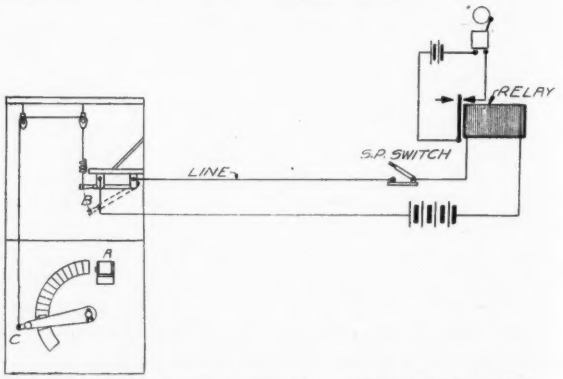
When the load was light, the motors did not divide the load at all well. That made but little difference. It was found advisable to run with rather slack well dressed belts. While the arrangement was not entirely satisfactory, it helped out during the temporary overload and enabled it to be carried without any cutting of the line shaft or any use of clutches.

Some time after, the same experiment was tried with another pair of motors without success. They would not work together under any conditions. Current in both cases was taken from a 220-v. 3-wire system. The generators were driven by gas tractors and the voltage varied considerably.

Motor Circuit Alarm

By A. P. Sitton

WE HAVE a Goulds Triplex water pump run by electric motor which furnishes all water for the Fort. This pump is about ½ mile from the engine room or power plant. From some cause this pump would stop during the night and the ampere load varies to such an extent that the man on watch could not tell when it did stop. I rigged up an apparatus as illustrated and ran the wires to my quarters, connected to switch relay and bell. We have had no trouble since.



ALARM SYSTEM THAT SIGNALS WHEN MOTOR STOPS

The starting box is shown in position for ringing the bell, in other words, the pump is stopped. On starting the pump, of course, the lever is raised to position A, where the magnet holds it. Then the switch is pulled out into position of dotted lines. When the pump stops, the lever falls to position C, and by string connected to spring on switch and run through pulleys at the top, closes the switch. This closes the relay and rings the bell at house or quarters.

REPORT OF the Census Bureau for 1914 shows that, in the electrical industry, there are 1121 establishments engaged in manufacturing electrical apparatus, with an annual output of $359,412,676. While the number of establishments has decreased by 30 since 1909, the value of the output has increased 49.7 per cent.

The value of dynamos manufactured was $23,233,437, an increase of 34.8 per cent since 1909. Transformers manufactured were of the value of $13,120,065, an increase of 51 per cent in number, 61.7 per cent in capacity, and 49 per cent in value since 1909. The motors manufactured were valued at $44,176,235, an increase of 37.7 per cent in 5 yr., while the increase in capacity manufactured was 62.5 per cent. In the 5 yr. from 1909 to 1914, the tungsten lamp has captured the market, the increase in percentage being 534 in numbers of 90 per cent in value, while the carbon filament has decreased 74 per cent in numbers and 74 per cent in value.

Duplex Exciter Sets

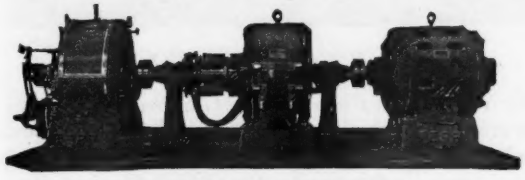
ECONOMY, RELIABILITY AND FLEXIBILITY OF OPERATION OBTAINED BY EMPLOYMENT OF DOUBLE DRIVE

ONE of the most important pieces of the apparatus in the power plant is the exciter. This machine bears to the alternating-current generator the same relation that the boiler feed pump does to the boiler. Failure of exciting current means immediate failure of the main units, so that reliability in this piece of apparatus is of paramount importance. From the standpoint of reliability, the ideal exciter drive is a steam drive, as the boiler is usually the last piece of apparatus subject to failure of operation.

For steam-driven exciters the turbine has proved reliable and flexible. Furthermore, the maintenance cost is low. For obvious reasons small turbine exciter sets are run noncondensing, and where the load characteristics of the station are such that all the exhaust steam can be used in the heater, this makes a most economical proposition. There are many stations, however, where the load-factor is low and all the exhaust steam from the exciter cannot be used. This results in a direct loss by blowing off steam from the heater.

From an economical standpoint, therefore, the motor-driven exciter is often more efficient than a steam-drive. The serious objection to this type of auxiliary, however, is that when anything happens to interrupt the current supply to the exciter motor, the excitation is immediately lost, and the main unit is out of commission until some auxiliary exciter can be started up.

Duplex exciter sets, such as the Terry, manufactured by The Terry Steam Turbine Co. of Hartford, Conn., combine all advantages of a motor-driven exciter with the reliability of the steam-driven unit. These sets consist of an exciter-generator coupled to a motor at one end, and to a steam turbine at the other end. For normal operation the set runs as a motor-generator set. Should anything happen to interrupt the supply of current to the motor, or should anything happen to the motor itself, the speed will drop slightly, the governor



TERRY DUPLEX EXCITER SET

of the turbine will immediately take hold, and the machine from then on runs as a direct-connected turbo-exciter set. The action of the special governor fitted to these sets is so sensitive that when the switch controlling the motor is pulled, the turbine will instantly take hold of the load without any appreciable fluctuation in voltage.

The turbine governor is also fitted with a speed-changing device used during normal operation to divide the load between the turbine and the motor, so that the unit can be operated at its maximum efficiency at all times. With this device, as the station load increases and with the demand for exhaust steam for the feed water heater, the load can be gradually shifted from the motor end to the turbine end. The proportion of the load carried by the turbine can be varied at will from zero to 100 per cent, to supply exactly the amount of exhaust steam needed to maintain proper heat balance in the heater.

This device does not affect the operation of the unit under emergency conditions.

The advantages of the Terry Duplex Exciter are: (1) It obviates the need for both motor-driven and steam-driven exciter sets, such as are now installed in many stations, and thereby saves both in first cost and in floor space; (2) It gives absolute certainty that excitation will not be lost as long as there is steam at the turbine; (3) When anything goes wrong in the station, all available help can be used elsewhere, as the exciter set can be depended upon to take care of itself; (4) The set can be driven economically from the turbine end when exhaust steam is needed at the heater, and the switchboard operator can, without leaving the switchboard, instantly shift the drive from motor to turbine; (5) In normal operation a better all-day efficiency can be obtained (by shifting the exciter load from the motor-end to the turbine-end of the unit as the demand for exhaust steam increases) than can be attained with either a straight motor drive or a straight turbine drive; (6) The main generating units are relieved from carrying the exciter load during peak periods, because during these periods turbine drive for the exciter unit is much more efficient than motor drive.

Scale in Water-Tube Boilers

ENGINEERS and other persons familiar with the operation of steam boilers, knowing that scale forms most rapidly in the lower tubes of horizontal water-tube boilers, commonly believe that the amount formed in the upper ones is negligible. With this idea firmly fixed in their minds, many engineers (probably a large majority of them), are in the habit of cleaning only the tubes in 2 or 3 of the lower rows. In this way considerable labor is saved that would otherwise be expended in removing and replacing tube caps, turbining tubes, and grinding headers and caps. Furthermore, the boiler is not out of service for so long a time—a fact which is of considerable importance in a plant that is working to its full capacity.

In a certain large manufacturing plant where water-tube boilers are used, it has been the practice to remove the scale from *all* the tubes whenever the boilers are shut down for cleaning; but on account of the great pressure of business and the corresponding necessity for keeping the boilers in service as continuously as possible, the chief engineer at this particular plant determined to find out the actual facts about the relative amount of scale formed in the upper and lower row of tubes, so that he could judge, intelligently, whether or not he could afford to save time by omitting the cleaning of the upper ones.

The boilers in this plant are cleaned internally every 6 mo., and at the regular cleaning time a Babcock and Wilcox boiler of 400 hp. was selected for a definite test. The boiler that was chosen consists of 14 sections, each of which is 14 tubes high, and it is equipped with an

automatic stoker, an economizer, and an open feed water heater.

As a preliminary to the actual test, all loose scale was removed from the mud drum. The tubes in the upper row were then turbined, and the scale from them was carefully collected and placed in an iron tray. The same procedure was followed with each of the other rows, care being taken to mark every tray with a number corresponding to the row of tubes from which the scale that it contained was obtained. After the cleaning operations had been completed, the various trays were placed on top of the boilers that were in operation, and were left there for 24 hr. to allow the moisture to dry out. The scale in each tray was then weighed separately, and the results are given in the accompanying table. Tray No. 1 contained the scale taken from the tubes in the bottom row, and the others follow in order, No. 14 representing the top row of tubes.

Tray.	Lb.	Tray	Lb.
No. 1	11.44	No. 8	7.56
No. 2	10.69	No. 9	7.31
No. 3	10.56	No. 10	8.25
No. 4	8.12	No. 11	7.44
No. 5	8.25	No. 12	7.19
No. 6	6.62	No. 13	8.25
No. 7	6.44	No. 14	7.00

These figures reveal some interesting facts. They not only confirm the general belief that more scale forms in the lower tubes than in the upper ones, but also show that, in this case at least, the smallest amount was deposited in the tubes at about the middle of the height of the boiler, and not in the highest tubes, as was expected. It is evident that a test of a single boiler in this way does not prove conclusively that the least scale is always formed in the middle tubes, but the results that are here given are nevertheless suggestive, as the test was carefully conducted, and every precaution was taken to have it as accurate as practicable. The results show, at all events, that a very considerable amount of scale is deposited in the upper tubes, and that it is therefore important to give them as much attention, when cleaning, as the lower ones receive, if the efficiency of the boiler is to be maintained; though the danger of overheating the metal is of course greatest in the lower rows, immediately over the fire, because there is where the heat is most intense.—The Travelers Standard.

U. S. Civil Service Commission announces an examination for expert driller, to fill vacancies in the Bureau of Mines, Department of Interior, at salaries ranging from $2160 to $3300. At least 6 yr. experience in oil and gas well drilling, of which at least 3 must have been actual drilling experience, including experience in drilling through high-pressure gas sands without permitting the gas to waste to the atmosphere, in under reaming and drilling through caving formations and carrying long strings of casing, and in cementing wells to exclude water by introducing cement either by the tubing or cartridge method, are prerequisites for consideration. Applicants must have reached their twenty-fifth but not their fortieth birthday on the date of the examination. Apply for Form 2118. Examination date, Sept. 12.

Improving Power Station Grounds at Low Cost

By L. R. W. Allison

THE well-kept power station is universally admired and commended. Equipment maintained to the highest point of efficiency usually indicates a similar condition with the power plant proper—clean walls, floors and windows, polished brass and metal work, with orderly and systematic arrangement of portable tools and apparatus.

Equally essential from the viewpoint of effective operation, but frequently neglected, are the grounds and surroundings of the power plant, particularly the smaller station, where the possibilities for noticeable improvements at trifling cost are often many. Grounds allowed to grow wild and rough, with tree stumps, weeds and crude vegetation, are a constant eye-sore, not only to the worker in the plant but to others; while to the visitor such out-of-door conditions tend to offset the atmosphere of cleanness and neatness to be found within.

Carefully laid-out grounds, with lawn and shrubbery trimmed and maintained, enhance the power station as a point of community interest many fold, far more than an estimate of the intrinsic cost of such betterments

CONCRETE LAWN STUMP

would show. In connection with features of this improvement work, concrete offers particular advantages, being capable of producing many interesting and practical novelties for ground decoration at low expense.

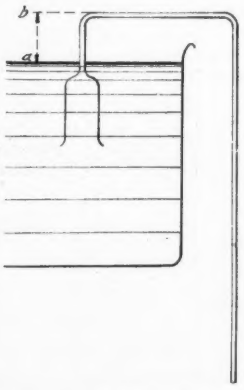
The simple yet artistic lawn stump shown in the accompanying illustration indicates the possibilities of concrete for this service. This lawn stump is about 18 in. high, having a diameter of 13 in. at the top and 24 in. at the bottom. The entire center is cored, or hollowed out to allow plants to root in the ground. The stump can be made of a 1:2 mixture of white cement and sand, requiring an aggregate of about 10 qt. of cement to 20 qt. of clear white sand; it can be produced at a cost of from $2 to $3.

When putting an engine together, give each part a bath in a bucket of gasoline, and then give all rubbing surfaces a coat of oil before putting such parts in place. —The Gas Engine.

Foreign Development in the Power Plant Field

SIPHON WITH AUTOMATIC FLOW; SORTING OF COFFEE BEANS BY ELECTRICITY; AUTOGENOUS WELDING TESTS. BY J. H. BLAKEY

THE disadvantage of the ordinary siphon, that it must be started by suction or otherwise, is overcome by the form of siphon shown in the illustration, at least in cases where the distance from the level of the liquid to the highest point of the siphon is small. It is operated by placing the finger at the end of the longer leg, thus preventing the escape of air. When the bell-shaped end is pressed down into the liquid, this rises within the bell to a height determined by the height of the liquid level above the mouth of the bell. This has the effect of compressing the air within the siphon. When the finger is removed the air pressure becomes normal, and the liquid receives an impetus which will,



AUTOMATIC SIPHON

if the distance is not too great, carry it over the curve. This form of siphon is useful in the handling of acids or liquids which are poisonous or otherwise injurious.—From La Nature.

SORTING OF COFFEE BEANS BY ELECTRICITY

SORTING of coffee beans, when it is a question of sorting according to size or shape, has always been done by machinery; but until recently sorting according to color had to be done by hand, which, of course, is slow and expensive. A short time ago, a machine was put into operation in one of the English colonies by means of which even this is done mechanically. The principle on which the machine is constructed is the varying electrical resistance of selenium according to the amount of light passing through it. A small piece of this material is placed in an electric circuit in such a way that the light from each bean as it passes in a groove before it, is reflected upon the selenium, the resistance of which is thus varied from moment to moment. This change of resistance is used to operate a separating needle in the groove, by means of which the dark colored beans are directed into one channel, while those of light color are passed into another.

AUTOGENOUS WELDING TESTS

THE SWISS Society of Steam Boiler Owners has published the results obtained by the Federal Testing laboratory in a number of tests made to ascertain the strength of autogenous welding of boiler plates. These tests were made on boiler plate of the same kind by 14 different manufacturing concerns, each test piece being 15 in. square and 0.5 in. thick. The plates were of soft Siemens-Martin steel, and the tests were made to find the strength of this method of welding applied to cracks in the solid plate and also in the tube plate. Experiments in tension, bending hot and cold, bending by hammering and resistance to acids, have resulted in the compilation of comparative tables. In a general way the conclusions arrived at may be stated as follows: Much depends on the preparation of the parts to be welded, and on the skill of the operator. The strength of the joint depends largely upon the even heating of a sufficient area of the plate around the defect, in order to prevent the occurrence of stresses on cooling. It is necessary to reject entirely welded plates for positions in which bending stresses are liable to occur. Finally, the Society recommends the adoption of the value 0.6 for the relation of the strengths of welded and perfect plate, and the use of a factor of safety not less than 4.75 for welded plate.

IN THE PRESS BULLETIN of the U. S. Geological Survey is found an interesting discussion of the peculiarity of streams in flood. It has long been a matter of observation that swift streams have a higher level at the center than near the banks, and that driftwood moves to the banks during the rise and maximum of a flood and returns to the center as the waters fall, but the explanation of this has not been forthcoming. Different causes create distinct sets of forces acting at the same time but independently in the stream, and any particle of the water in motion is affected by the forces of various different sets. Probably the elevation at the center during flood results from roughness of the bed. The irregularities at the bottom and sides turn parts of the current that strike them away from the the banks and upward from the bottom of the channel. These particles may move only a short distance in the new direction, but the accumulated energy and the effect on other particles sets up forces, acting toward the upper middle part of the stream, that tend to pile up the water slightly in that part of the stream section. This movement goes on until the greater hydraulic head balances the deflecting forces. This rise at the center is greater in relatively deep and narrow streams than in shallow and broad ones, and is greater in rough than in smooth channels.

Driftwood action during floods is due to the fact that the deep, central part of the stream, because it has greater freedom of flow, tends to rise slightly in advance of the margins, and also to fall more rapidly than the margins, thus causing the drift to slide outward towards the bank during the rise, and inward toward the center during the fall. Eddies naturally play an important part in local action, since much water may be drawn off at a distance below the surface by eddy action, creating a low spot at that point, and drawing the drift toward the center of the eddy.

Practical Points on Raw Water Ice--II

THE ICE TANK. BY A. G. SOLOMON

ICE TANKS in raw water plants are the same in general construction as for any other can system, with the addition of the air pipes used in the agitation of the water. A suitable sized header is run from the blowers and branches extend under the framework of the tank top (see illustration). These branches are again reduced to the smaller branches which supply air for the proper number of cans, generally from 6 to 12. Cocks or valves are put on each of these small branches so that they can be shut off after the final coring is done.

Different methods of both heating the air and cooling it have been tried, but I believe that all such apparatus has been done away with in the most successful and modern plants. The temperature of the air leaving the blower will vary from 85 to 120 deg., according to

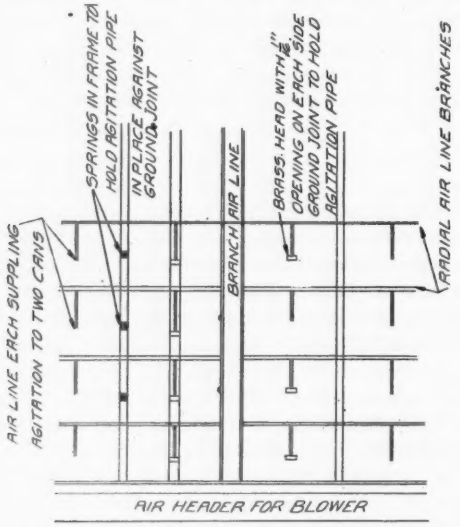

SPRINGS IN FRAME TO HOLD AGITATION PIPE IN PLACE AGAINST GROUND JOINT
BRASS HEAD WITH 1/4" OPENING ON EACH SIDE GROUND JOINT TO HOLD AGITATION PIPE
BRANCH AIR LINE
RADIAL AIR LINE BRANCHES
AIR LINE EACH SUPPLYING AGITATION TO TWO CANS
AIR HEADER FOR BLOWER

FIG. 1. DETAILS OF AGITATION PIPING

weather conditions and the pressure carried. This air is, of course, greatly cooled before entering the ice cans in its passage through the pipes under the tank cover. Little if any difference in the time of freezing or in economy can be noted with the different temperatures. Also, the moisture contained in the air need scarcely be taken into consideration.

The blowers are provided with suitable pop or relief valves, so that the pressure is constant while different branches are being opened and closed, as is the case during all hours while ice is being pulled and cans filled.

PULLING AND FILLING

IT IS a little more difficult to get a proper crew on the ice tanks for a raw water plant than for a distilled plant. The pulling of ice, filling of cans and handling of the air must be done carefully and systematically.

In starting up a tank at the beginning of a season or starting a new plant, the cans are first all filled with the filtered water to be used and the air pipes inserted properly, but the air not turned on. The temperature must be watched, and when it gets too near the freezing point, the air is turned on. Then a man must begin at once to look over the tank and see that agitation is going on in each can. He must lift every lid, and wherever the agitation is entirely or partially stopped, it must be made right. Often small particles of scale or dirt become lodged in the small air openings. This is easily removed with a small piece of wire. The blower and all the air lines should have been thoroughly blown clean before starting up.

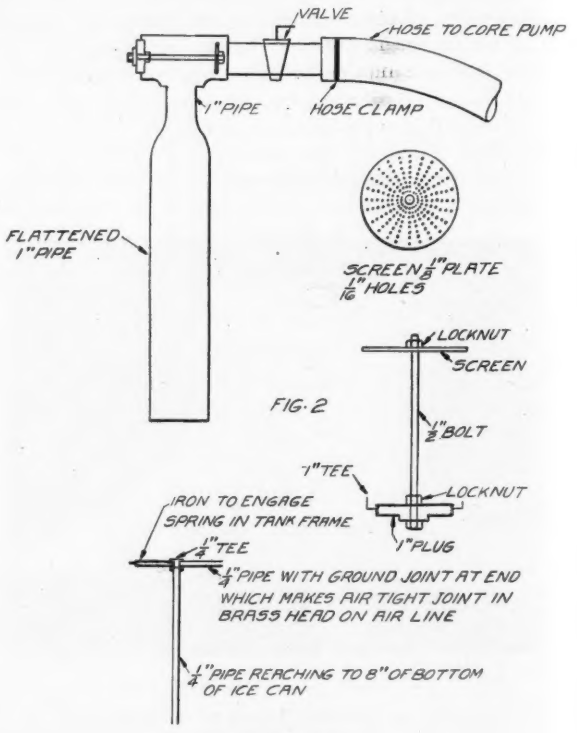


FIG. 2. CORE SUCKER AND SCREEN

FIG. 3. AIR AGITATION PIPE WHICH EXTENDS INTO CAN

As the temperature is gradually lowered and the shell of ice becomes thicker, some of the air pipes will be frozen in on account of their not being straight or not being inserted properly. These must be removed and others put in their places. The closer the ice freezes, the closer must be the watch kept on the agitation.

On a large tank, when freezing the first pull, do not wait too long to begin withdrawing the core water and filling with fresh. Start soon enough that you will get over the tank before the air pipes freeze in. The agitation must be watched at all times, as it will be found to be almost the most important part of the raw water system. When all the coring has been done, the

tank is allowed to freeze up solid and then the pulling is begun.

Pull and fill every other row, is the best and easiest way to handle it. The ice pullers must be well trained in the handling of the can filler and the air. The air must be turned into the filled can as quickly as possible, or a white, frosty outside will form on the block. This is more likely to happen with low temperature brine than if higher temperature is carried. It takes a very short time for a thin layer to freeze to the can, and if the water is not agitated, this layer will be white and the appearance of the cake will be spoiled.

After an ice puller is "broke in" properly, there is hardly any excuse for failure to make good ice. Of course, some ice will be bad owing to the agitation stopping; but, by continual watching, this will be a very small amount.

Coring and Filling Cores

The unfrozen core water is taken out by means of core pumps through suitable hose and a flattened pipe which will reach to the bottom of the core.

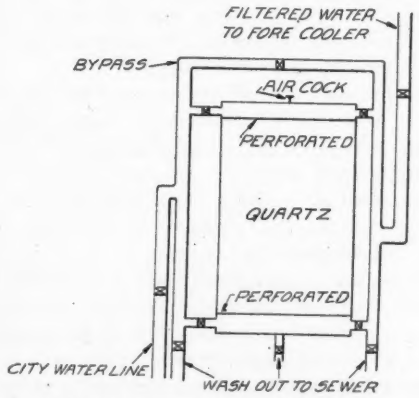


FIG. 4. QUARTZ FILTER AND CONNECTIONS FOR WASHING

The core water must be entirely sucked out and a little fresh, clean water also used to wash off any sediment that might be clinging to the ice. Then the core is filled with fresh water and the block is ready for solid freezing without agitation.

Cores are generally sucked when the hollow is from 2 to 3 in. wide at the top. Coring twice is sometimes done; the first time, when the core is about 4 or 5 in. wide, and the second time when about 2 in. I doubt if any benefit is derived from all this extra labor.

Water

The water used for filling the ice cans can come direct from the city main or from a well, if that is the source of the water supply. If taken from the city main, no pump is required to handle it.

The water is first allowed to pass through a good quartz filter, where most of the sediment is caught. This filter must be provided with suitable piping so that it can be thoroughly washed both from top and bottom. Do not be afraid to waste a little water in the washing. Find out as soon as possible how often the filter needs washing and then make it an ironclad rule that it is washed regularly. In most cases, these filters need washing about every 4 hr.

From the filter, the water goes to the fore-cooler or storage tank, which is provided with coils, and the temperature is lowered to that point best suited to the conditions of the plant. Sometimes cloudy ice is caused by lowering the temperature of the fore-cooler too much and sending the cold water to the cans, where it is frozen too rapidly and a thin sheet is formed before the air agitation is begun. Get the water as cold as possible in the fore-cooler without spoiling the looks of the ice.

I do not believe in using the core water over again for filling cans, but it is done in some places with varying degrees of success. Although it is good and cold, it is also full of sediment, which is hard to filter out. Where it is used, it is sent through a good filter after leaving the core pump and then mixes with the water in the fore-cooler. This core water filter will require close watching and frequent washing, as the sediment that is caught in it is very fine and if not washed out it will soon penetrate through the quartz or charcoal. A connection must be made with the city main so as to get pressure enough to wash the core water filter properly.

But the best place for the core water is over the ammonia condenser, as there it can do no harm but will do a lot of good. Since there are no boilers which require water, the core water and also the water used in the dip tanks can be used over the condenser. A sump or well can be put at a low point to catch all the water from the ice dump and dip tank. A float controlled pump will take care of this sump and put the water on the ammonia condenser. In this way, the loss of water by evaporation and wind will be made up by good cold water.

Core pumps are the same as any other cold water pump, and their work being easy, they will give no trouble at all. Small sticks, matches and bits of waste or other rubbish will cause annoyance if allowed to enter; but, by properly screening, these things will be kept out. The best place for a screen is right at the top of the pipe which extends into the can, as illustrated. When 2 or more core suckers are in use on one pump, each sucker must be shut off when not submerged in water. Otherwise the pump will become air bound.

At the Commencement of the University of Illinois on June 14, 1916, 222 baccalaureate degrees were granted to students of the College of Engineering, distributed as follows:

In Architecture	27
In Architectural Engineering	36
In Ceramics	10
In Ceramic Engineering	5
In Civil Engineering	39
In Electrical Engineering	43
In Mechanical Engineering	44
In Mining Engineering	3
In Municipal and Sanitary Engineering	5
In Railway Engineering	10
Total	222

In addition to the above, 21 master's degrees, 21 professional degrees, and 3 doctor's degrees were conferred by departments of the College of Engineering.

A Refrigerating Plant Trouble

FAILURE TO CLEAN OUT SCALE TRAP STOPS UP SYSTEM. BY THOMAS G. THURSTON

MONDAY was generally a light day in the plant, especially in the forenoon, so the engineer decided to repair a small leak in one of the expansion coils of the refrigerating system. He shut off the valve in the main liquid line, at the receiver and pumped the coils down to about zero. Then he went to the coolers and shut off all the expansion valves and all the suction valves on each coil except the one he wanted to pump out for repairs. He continued pumping until the suction gage registered 25 in. vacuum, then shut down the machine, closed the suction valve and got ready to break the coil open at the joint where it was leaking. He was much surprised to find when he loosened up the flange bolts that he still had pressure on the coil, so went back to the engine room and found he again had about zero pressure on the suction gage. He pumped down to a little over 25 in. again and kept the compressor running slowly for quite a while, holding the pressure at this point so as to give the ammonia which was lying in the coil time to evaporate. When he opened the joint again, however, the coil still had pressure on it. He was sorely puzzled this time, because when he came back to the engine room there was still about 10 in. vacuum on the gage. He suspected the gage might be wrong, so he disconnected it, but the indicator came to zero as soon as it was open to the atmosphere. Evidently the gage was correct.

He reconnected it again and started up the machine once more. This time the pressure came down in a few minutes; so waiting until he had a good 25 in. of vacuum he slowed down the machine until it would just hold the pressure, and telling the oiler to watch it went up to the coil. It still had pressure on it. It was getting late, some of the coolers had already begun to go up and there was a carload of fresh produce coming in, so he decided to let the job go until some other time.

He opened up the suction valves on all the coils again and set the expansion valves, then returned to the engine room where the suction pressure still showed at 25 in. and the machine was turning over slowly. Leaving the machine running this way until the suction pressure should come up, he opened up the valve in the main liquid line at the receiver.

Generally the suction pressure begins to go up at once when the liquid is turned on, but in this case there was no increase in the pressure after half an hour. In the meantime the engineer had gone over every valve he could think of and found them all open. By this time the low temperature coils had gone up several degrees and all of the coolers had gone up more or less. The head pressure had dropped to about 60 lb. and no sign of liquid in the receiver which normally ran with the glass full. By now the engineer was, figuratively speaking, "up in the air." He had only been a few weeks on the job and his previous refrigerating experience was very limited. Finally, happening to think of a friend of his operating a big refrigerating plant, he called up on the 'phone and informed him of his predicament. The friend was unable to tell offhand what the trouble was but after the symptoms had been related to him, came to the conclusion that the suction line was obstructed at some point and told the engineer how to proceed to locate it.

There was of course a stop valve at the compressor; about 20 ft. back in the suction line was a scale trap; and back of this was another stop valve. From here the suction line ran straight back to the first coil which was the one in which the trouble had occurred. The method was first to try the blowoff of the scale trap. This showed no indications of either pressure or vacuum. Evidently it was blocked. Next, the bonnet on the stop valve back of the trap was loosened. Here the ammonia began to blow at once so it was tightened again and the value shut tight.

Next the flange on the scale trap between the trap and this valve was loosened. Here was also strong pressure. Then was tried the flange on the other side of the trap between it and the machine. Here was found a vacuum; hence, the trouble was evidently in the trap.

The engineer connected up a hose and loosening the flange on the pressure side of the trap to let the gas out between the trap and the valve back of it, he kept a small stream of water running over the flange where the ammonia escaped to absorb the ammonia so they would not be driven from the room.

When the pressure was off, he removed the top from the trap. It was full of a semisolid mass composed mainly of oil, scale, and shreds of packing. When the pressure was pumped down, the low temperature of the ammonia evaporating in the mass had solidified it and thoroughly obstructed the passage. Connecting up a steam hose and keeping this blowing on the trap soon had it loosened up so that they could remove the contents. When the pressure was turned on again after cleaning the obstructed trap and blowoff valve and replacing the cover, the engineer was much relieved to find that his suction gage registered practically condenser pressure. The reason for all this trouble was evident.

The blocked oil trap of course prevented pumping out the coil. When the liquid was turned on again, there being no outlet from the coils the liquid accumulated in them. When the liquid was all gone, part of the gas in the condenser passed over to the coils, also, and condensed in them, the coldest coils in the low temperature rooms taking up the gas most rapidly; the coils in this case acted as a heater, transferring the heat in the noncondensed gas to the room, running the room temperature up at more than normal rate. Neither the present engineer or his predecessor had ever taken the trouble to blow out the scale trap. It goes without question that it was periodically attended to after this.

U. S. CIVIL SERVICE COMMISSION announces an examination, Sept. 5, for assistant material engineer, to fill 2 vacancies in the Bureau of Construction and Repair, Navy Department, Washington, D. C., at entrance salaries of $5.04 and $6, respectively, and vacancies as they may occur in positions requiring similar qualifications. Competitors will not be assembled for examination, but will be rated on general education and technical training, general and special experience, and fitness. Apply for Form 1312.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Installing An Engine to Drive Overhead Jack Shaft

SOME TIME AGO it became necessary to deliver 250 hp. on a jack shaft on the second floor of a building. To do this, we decided to relocate an 18.5 by 18-in. high-speed engine, and following is the manner in which we lined the engine to the jack shaft:

The jack shaft, 1, in Fig. 1A, was calipered at 2 and again at 3 and found to be the same diameter. Two plumb lines, 5 and 6, were now dropped over the shaft, as shown, with holes bored in the floor to enable the plumb bob to drop through the floor about

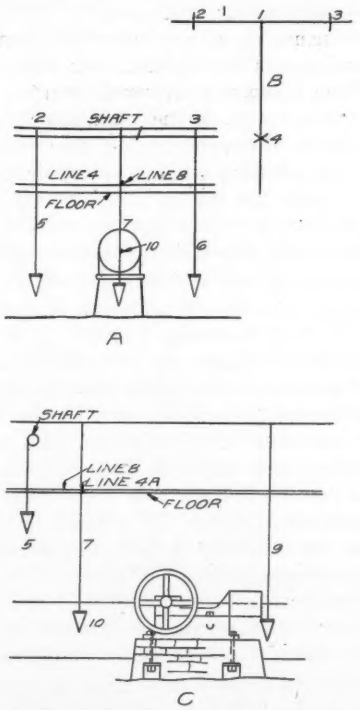


FIG. 1. ELEVATIONS SHOWING RELATIVE LOCATIONS OF ENGINE AND JACK SHAFT

a foot. A line, 4, was run across the floor so that it just cleared and so located that it just touched the plumb lines, 5 and 6, and was parallel to the jack shaft. Another plumb line, 7, was then dropped through the floor to within 2 in. of the first floor.

Another line, 8, clearing the floor and just touching line 7, leads across line 4. On the floor, using line B, Fig. 1B, (line 4 Fig. 1A) for a base of operations, set off with a tram the distances 2 and 3, making arcs as shown, and then with 2 and 3 as a center and a longer radius, scribe the arcs at 4, as shown. A line stretched through 1 and 4 will be perpendicular to line 2-3.

Establish line 8 parallel to 1-4 and touching line 7. Line 9 was dropped to touch 8. Line 10 was run so that it barely made contact with the plumb lines, 7 and 9, and represented the center line of the engine.

The wooden templet for the foundation bolts having the center line through the cylinder and crank shaft marked on it was hung and stayed so that its longitudinal center line was under the line and the concrete foundation was built.

As the engine had been erected in the shop and was of the self contained type, it was only necessary to remove the piston, crosshead and connecting rod, then

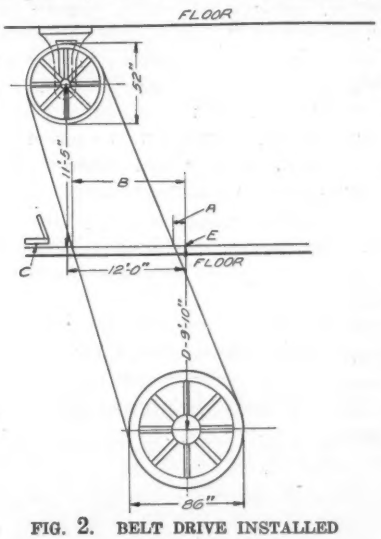


FIG. 2. BELT DRIVE INSTALLED

run the line through the cylinder across the center of the crankpin's length, keeping the line touching the plumb lines.

The holes in the floor for the belts to pass through were located as follows:

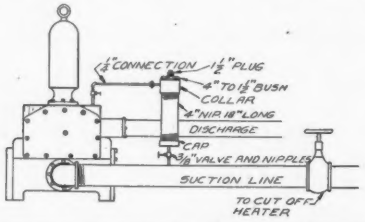
We drew in chalk on the floor, with all dimensions, the size and location of the flywheels and receiving pulleys, as shown in Fig. 2. The carpenter was instructed to bore a small hole through the floor directly above the center of the crank shaft.

Then we measured on the chalk drawing the distances, A and B, from the center line, D, and laid them off on the floor that distance from the small hole bored in the floor at E, as shown in Fig. 2. The bevel, C, was set to the chalk sketch to get the angle the belt would take, then the holes for the belt were cut on that angle, care being taken to cut the hole on the slack side of belt larger than the other. RECEIVER.

Boiler Graphite Feeder

HAVING DECIDED to use boiler graphite in our 3 150-hp. horizontal return tubular boilers, and not having a compound pump, we made the following device.

To the bottom of a 4-in. nipple 18 in. long was screwed a cap which was drilled and tapped for a ⅜-in. pipe connection; on top, a 4-in. collar was put after having been drilled and tapped for a ¼-in. pipe connection; a 4 to 1½-in. bushing was screwed into the coupling, and a 1½-in. plug into the bushing, the plug being used when filling the container with boiler graphite. The bottom, or ⅜-in. connection, was connected to the suction, and the top, or ¼-in. connection, was connected to the discharge side of the boiler feed pump.



METHOD OF FEEDING BOILER GRAPHITE

To operate: close ¼-in. valve, remove filling plug, open ⅜-in. valve wide so that, should any of the graphite stick, it is loosened by the pump drawing air through the opening in the top. Close ⅜-in. valve, fill with graphite, put in plug, open ¼-in. valve wide and crack ⅜-in. valve. Should connection to suction line become plugged very tight, valve to feed water heater is closed, allowing the pump to draw as much air as possible through the device.

Before filling, we thoroughly mix graphite with hot water, using about 3 pt. of graphite and 6 pt. of water to the filling.

This graphite feeder has been used nearly 2 yr., and has given excellent satisfaction thus far. JACK L. BALL

Pump Maintenance

THERE ARE many types and makes of pumps on the market used for and in a wide range of purposes, and while these remarks are intended for power plant pumps in general, there are many of them that apply to all pumps equally well.

When any pump is running, it should be making its full stroke each direction; if it is not doing this, it is wasting steam in making many extra strokes. When a pump's stroke has to be shortened to make it keep running, it shows that there is something wrong with the adjustment. Short strokes also mean (if allowed to continue), the formation of shoulders at each end of the steam and water cylinders, and on the valve seat in the steam chest. These cause such troubles as breaking piston rings and followers in the steam cylinder, sticking of the plunger, being unable to pack it properly on account of worn shoulders, and a steam-bound pump if the valves should ride up on the shoulder formed on the valve seat.

All of the above-mentioned troubles can be avoided by properly adjusting and setting the steam valves and securing them against tampering by inexperienced hands. This can be done, as far as the moving of the tappets on the valve rods is concerned, by drilling a hole through them and the rod (when they are set), and pinning. Should it become necessary to make small changes in them afterwards due to the wear of the valve motion parts it could be accomplished by placing the correct thickness washer on the crosshead.

Often, in the vertical type of pumps, they will make only a part stroke on the up stroke, due to a loosely packed stuffing box; on the valve stem, there must be enough friction to keep the valve from dropping of its own weight.

There are too many types of pump valve gears to try to describe the setting of the valves, but the following will apply to a great many. The striking points of the piston must first be obtained and marked at a suitable location (such as the pump tie rods), and the center of these will be the proper location of the piston for setting the valves. Uncover the valves and set them to cover the stem ports equally; that is, the center of the valve stroke. Then set the tappets equal distance from the valve stem crosshead, a little at a time, moving the valve up and down each time the tappets are moved until it is seen that a full opening is obtained of each steam valve port at each end.

Pump alinement is a very important item and satisfactory running can be obtained only when a pump is in line. When a pump is delivered from the builders it is properly alined; yet, in the installation, it may have been put out of alinement by the pipe connections or its base or the building settling, or other causes, therefore after a pump has started to show wear on one side of the cylinder it is time to re-aline it. The inspection for these conditions should always be made shortly after a pump is installed and run for a few days.

When a pump is idle, it should be moved every day to prevent it from becoming bound and to keep it in good order for immediate use. It should be kept well drained of water, and the drain cocks should be closed after draining to prevent air getting in to rust the cylinder. In plants where there are pumps located so that in winter they might be liable to freeze up, the drains had best be left open or steps taken to prevent the accumulation of water. If a pump is not going to be used for an indefinite period, the steam end parts inside and out should be given a coat of vaseline, and when the pump is to be put back into use it should be all wiped out from the inside to prevent its going into the exhaust steam, if it is part of a condensing plant.

The water end of the pumps must come in for a good share of attention. To obtain satisfactory results, the valves must be kept in perfectly tight condition. Metal valve discs should be frequently ground into their seats with a mixture of ground glass and grease. Sometimes a bitstock can be used to good advantage in turning the valve for grinding. Hard rubber valves sometimes give trouble by warping or dishing; it is bad practice to turn them over, for they will invariably break. There may be sufficient thickness to permit their being trimmed or turned straight on one side in the lathe; if so this will permit their use a while longer but new valves are the best remedy. The lift of the valve has a great deal to do with proper working. The rule is that they

must lift enough to permit the free flow of water through the valve; about ¼ the diameter will be the proper lift, never any more. Too little lift is generally the cause of the valves squealing or making a rasping noise. Care must be taken that the right spring tension is given; this depends on the kind of duty a pump is doing, whether high or low pressure. It should be sufficient to insure the proper closing of the valve, but never too stiff; this applies especially to the suction valves of a pump that has to draw the water to it. It will be readily understood that when water is delivered to a pump suction under a head of a few feet, it will open the suction valves itself; therefore consideration of this must be given in the spring tension. Springs, studs, valves and nuts should be well secured against getting adrift, these parts when they do get adrift usually cause damage to valves along the discharge line from the pump.

Care should be taken, when removing and replacing valve seats of pumps, that they are replaced the correct way; otherwise the work of overhauling is all lost. In many types of water valve chests, the upper and lower valve seats are held down by one long king bolt or stud, and if the proper care is not taken to see that the seats are both held down firmly with this bolt, the seat that is loose will give trouble by leaking around its edges. See that the seats are driven down hard (or pressed down) where they belong, then get the distance between the edge of the top one and the edge of the lower one where the king bolt shoulders will bear and compare it with the bolt shoulder distances; make them correct by use of washers.

A water plunger should never be packed too tight, as it will be an unending source of trouble in sticking and groaning and irregular working of the pump, scoring and wearing the cylinder unduly. Hemp packings should be soaked in water before being put in; in fact, nearly all water packing should be. Always whip or bind the ends of water packing to keep it from fraying out when cutting and handling. After packing a plunger, run the pump slowly awhile with the water end head off, if possible, and lubricate the cylinder a little with a good tallow, then stop and see if the plunger follower can be set up any tighter. Be sure that all studs are set up tight and all nuts secured and cotter pins in place. Loose water plungers are a common trouble, easily overcome by properly fitting the taper of the rod to the plunger. If the rod shoulders, it can be turned a little farther up on the rod; this insures the taper bearing. Sometimes the nut on the plunger is secured from backing off with a plate, yet the plate nut and plunger may back off together. The best method is to secure the nut by drilling a hole through it and the rod and inserting a cotter pin, the frequent removal of the plunger from the rod would perhaps mean that the nut might have to be set up more each time to be tight; this would mean a new hole, but a thin washer under the nut is better; a copper washer is best.

Distance pieces made from pipe and slipped on the packing gland studs will insure the glands of outside plunger packed pumps being drawn up square, thus preventing scoring and binding; but they cannot be taken up on when leaky unless taken off and cut down. Some gland studs have a nut each side of the gland (under and over); with these, it is easy to keep the gland rigged and set up square. The packing gland of the steam end piston rod should be adjusted when packed to allow just a small wisp of steam to show on the up stroke or in stroke, which keeps the rod lubricated and shows that there is no undue friction. It is well to apply a similar method on the water end rod.

There is a practice in some plants of placing a relief valve on the discharge side of the pump; the discharge of this is piped back to the suction chamber of the pump. This is a poor method; it has been the cause of many pumps becoming vapor bound, for the discharge of the relief valve at a high pressure will drive the water out of the suction chamber, causing it to lose its suction for a few strokes, therefore the discharge of these valves should be piped elsewhere.

Air chambers are good assets to any pump when placed near the pump in the direct line of the flow. They should have an air vent cock on top to admit air, to replace that absorbed by the passage of the water. A small check valve with a small globe valve as a regulator can be used to good advantage where there are no air chambers fitted on the suction side.

Every engineer would do well to obtain from the makers of his various pumps their descriptive matter. When any serious trouble is experienced their views and assistance can always be obtained by writing them and explaining the action of the pump. C. H. W.

A Unique Gas Engine Repair Job

THE WRITER was recently sent out to look over a 6-cylinder, 8½ by 11-in. gas engine rated at 125 hp., and employed for marine service. The engine had lost practically all of its power, being able to drive the boat at a speed of but 4 mi. an hour, although the usual speed was 9 mi. an hour.

Upon examination, it was found that instead of the explosion performing useful work, the oil and gas were being driven down into the crank case. The cylinders were so badly worn out of round that new rings would have been of no material benefit, so the writer suggested reboring; this proposal was, however, not received with favor, as 2 of the cylinders had been rebored but 2 yr. before and on account of the softness of the iron had not shown favorable results. This re-boring had also made the walls of the cylinder so thin as to leave but little material between the inner walls and the water jacket.

The owners therefore decided to order new cylinders, pistons and rings, but learned that these parts could not be obtained for another 3 mo. The writer then suggested bushing the cylinders and after due consideration this was done.

The cylinders, which were 24 in. long, were bored to a diameter of 9 in. for a distance of 12 in. from the top; the remaining depth was given a cut of 8⅞ in. in diameter, thus leaving a 1/16-in. shoulder at the center.

The bushings were made 0.006 in. large at the 8⅞-in. end and 0.008 in. large at the 9-in. end. At the shoulder was turned a small groove 1/16 in. wide, 1/32 in. deep and provided with 3 1/16-in. holes drilled at uniform distances around the circumference.

The object of employing this groove and holes was to allow the red lead to squeeze out as the bushing was brought up on the shoulder in the cylinder. The bushings, which were pulled in by means of a 1⅜-in. by 14-thread screw, were left 1/16 in. long at each end and faced off after in place. They were then each given a finishing cut to 8 7/16 in. in diameter with a counterbore at the end.

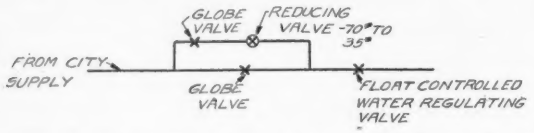
The old pistons were turned to a fit and new rings provided.

At first, when the engine was again placed in service, a little trouble due to excessive heating was experienced; but this was quickly stopped with the aid of a little white lead in the oil. The engine is now operating at its normal speed and drives the boat the required 9 mi. an hour.

R. B. MAGUNE.

Leaky Water Control Valve

FOR SOME TIME, it had been reported by our night man that our water heater was constantly overflowing; but since this trouble was not noticed during the daytime, not much attention was paid to the matter. One night, however, I happened to be at the plant and did see for myself that a heavy stream of water was continually being wasted. Since no returns were coming back, the trouble naturally was looked for in the regulating valve, but this was in good condition.



LOCATION OF VALVES TO OVERCOME DIFFICULTIES OF FLUCTUATING PRESSURES

We wrote the manufacturers of the valve for some suggestions. Among the questions asked by them was: "Under what pressure does the valve operate?"

We had noted that the pressure on the water line from the city supply was about 40 lb. during the day; but to check this up, we inserted a pressure gage in the line. It was found to vary from 35 to 40 lb. during the daytime; but, much to our surprise, we found that during the night the pressure mounted up to as high as 70 lb., due, no doubt, to the reduced demands on the city mains. This high pressure, of course, caused the valve to leak, whereas it held satisfactorily under the 40 lb. pressure. To overcome this, we installed a bypass line with reducing valve which was put in service during the night shift when the higher pressure came on.

M. A. SALLER.

Cause of Defective Indicator Diagram

WHILE TAKING some indicator diagrams, a short time ago, from a high-speed engine of the 4-valve type, I was a little surprised to get the diagram shown herewith. The point that attracted my attention was the irregularity in the expansion line of the crank end. Another diagram was immediately taken and showed the same conditions. Cases of this kind have been laid to many different causes, such as sticking piston, lack of lubrication, loose parts, cord slippage or stretching and whipping of the long cord, and as I had plenty of time I decided to find the trouble if possible.

The indicator with which the card was taken is a Lippincott to which is attached a Lippincott reducing wheel, the cord being connected directly to an arm bolted to the crosshead. The instrument has usually given good results, and was as I supposed, carefully adjusted. After unhooking the cord from the crosshead, I pulled out by hand slowly with the card still in place on the drum, and on the return stroke when the spring of the reducing

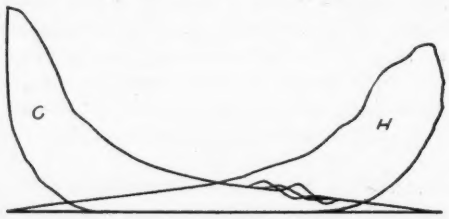


DIAGRAM WITH DEFECTIVE EXPANSION LINE

wheel and drum was taking up the slack, I noticed that there was a catch and a jerk when the pencil reached this spot on the card. The nature of the trouble led me to think that it was due to the reducing wheel spring. The reducing wheel spring cover was taken off and the trouble was found to be that as the spring was coiled up tight, the pressure put on the pin that connects the end of the spring to the spindle caused it to slip, and in returning, as the spring uncoiled it would catch and then jump ahead. After fixing this part there was no further trouble, and the expansion line on the crank end was as smooth as the one on the head end.

J. C. HAWKINS.

Cost of Steam for Blowing Soot

THINKING that it might be interesting to know how much the steam costs for blowing soot, I measured the orifices in a well known and typical soot blower and find the aggregate area to be 0.164 sq. in. Then, where boiler pressure is 150 lb. per sq. in. absolute; where coal costs $3.50 per ton of 2000 lb.; and where 9 lb. of water are evaporated into steam in the boiler per pound of coal I find the cost of steam to be very close to 25 cents an hour.

I substituted the values in the formula

$$\text{Cost of steam per hour in dollars} = \frac{0.0257\ p\ a\ c}{s}$$

where

p = steam pressure in pounds per sq. in. absolute;
a = total area of orifices in square inches;
c = cost of coal in dollars per ton of 2000 lb.;
s = pounds of steam evaporated per pound of coal.

I give the formula so that you can compute your own costs, for conditions in no 2 plants are alike.

Where plants are equipped with mechanical soot blowers in which there are many nozzles, use the total area in the same way as above. In the case of mechanical installations, the time required for blowing being very short, it will be found that the cost of steam is likewise correspondingly low.

N. G. NEAR.

Successful Kinks From The Plant

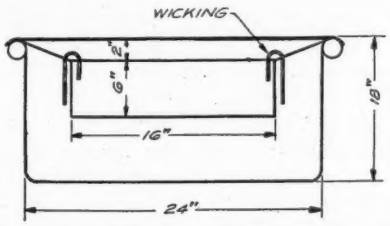
For Saving Time, Work and Trouble

Homemade Oil Filter

IN THE July 15 issue, R. B. C., on page 617, describes a homemade oil filter that gave good satisfaction.

Some years ago I saw an account of one, operating on capillary attraction principle, that I recently tried out, and find it very satisfactory, besides its being inexpensive—just the thing for a plant that does not use over 3 or 4 gal. of oil a day.

In making mine, I departed from description considerably, and here is how I proceeded: I bought an old galvanized steel oil tank, cut it in half, put in a bottom, wired the top where it was cut, and then had the tinner make me 2 smaller tanks, each about 16 in. in diameter. I soldered 3 lugs to these tanks in such a way that the lugs hooked over the rims of the outer tank, suspending the smaller tank about 2 in. below the top of the larger ones.



OIL FILTER OPERATED BY CAPILLARY ATTRACTION

I then procured some heavy woolen goods and cut it into strips 1½ in. wide, by about 8 in. long; these were hung over the edge of the small tank in such a way that about ⅔ of their length was on the outside. I poured a bucket of water into the small tank, and filled it up with the oil to be filtered; capillary attraction does the rest, and does it (apparently) satisfactorily, as I have used this re-filtered oil on my high-speed, 65-hp. gas engine for nearly a year, with no trouble.

I use about 1 to 2½ gal. of oil a run, and filter the same oil over and over again, using new oil only on my governor, and a few close-fitting bearings to the amount of ½ pt. a day. In with my to-be-filtered oil, I get the cylinder oil, which seems no detriment.

When the filtering material gets riled, I take it out, allow the oil to drip off, and then, between my fingers, strip off what sediment adheres, which seems to be what makes the filter work slower, whereupon my filtering-cloth is as good as new. This cleaning must be done about every 3 mo., and is not much of a job. In winter, I place my filter near a heat supply, and its work goes on just the same.

The above describes 2 filters, just alike, and made from the one oil tank.

The total cost was about $5.50 to $6.00, and I have been operating my engine now for 11 mo. on about 85 gal. of oil, and still have about 50 gal. of filtered oil on hand. We operate from dark to 11 p.m. every night.

This filter will work better if 2 layers of cloth are hung up, one over the other. In cleaning, be sure to get same ends on the outside, as they were before, lest some of the filtered-out dirt that may still be in the cloth will pass to the clean oil. I paid about 60 cents a yard for the filtering cloth. M. F. T. SCHIERBAUM.

Wire Cleaning Brushes

MOST POWER PLANTS have plenty of old steel wire hoisting cable lying among their scrap. This can be put to many good uses, some of which are, making tube cleaning brushes for cleaning both the fire side and water side of boilers, especially the tubes. Figure 1 gives the details of how to construct the holders and is almost self explanatory. The end of the cable is first soldered so as to make it easy to lead it through the holes. After the cable is put in each hole and cut off the desired length,

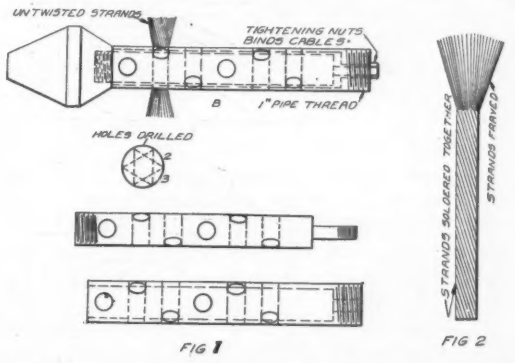


FIG. 1. DETAILS OF WIRE CABLE FLUE BRUSH HOLDER
FIG. 2. CLEANING BRUSH MADE FROM STEEL CABLE

the nut on the end of the center arbor of the holder is set up tight. This takes a strain on each piece of cable, making them fast in the holder; the parts of the cable sticking through are then untwisted or teased out, as shown. The pilot at the end is made the diameter of the inside of the tube and helps the quick entering of the brush in the tubes, and it also keeps the pushing strain on the wire fagots even, preventing them from being all laid down on one side. This pilot should be a little smaller than the inside to get the best results if the tubes are very dirty. When the wire cables become worn down, they can be taken out and new pieces put in; the holder being good for a great many sets.

Brushes for cleaning the interior parts of boilers such as headers and around the ends of tubes, nipples and

boiler connections, can easily be made by taking pieces of steel wire cable and soldering the strands at the end, as shown in Fig. 2, and then teasing out the strands at the other end.

For cleaning the inside of curved boiler tubes, long pieces of old cable which have one end tapered down and soldered and parts of their length frayed, so that they turn up, give good results. It is best to use a small cable and fray out a lot of strands, for a small cable can be drawn through the mud drums and is easier to bend at the right angle required at the lower end of the tube. The cable must be long enough to pass through the tubes and end enough to get hold of and pull.

C. H. W.

Crowning a Flywheel

RECENTLY it fell to my lot to erect a 750-hp. compound engine which was provided with a flywheel 78 in. wide, 16 ft. in diameter, made in 4 pieces.

The original purchasers had the wheel provided with 2 crowns, as it was desired to run 2 belts on the wheel to separate jack shafts.

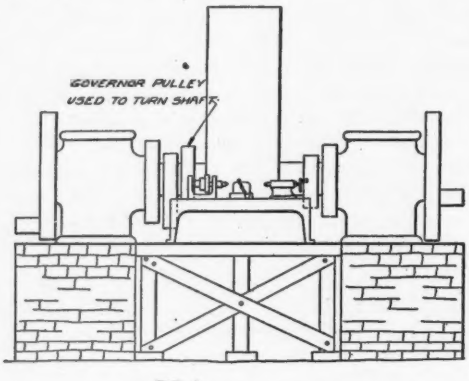


FIG. 1

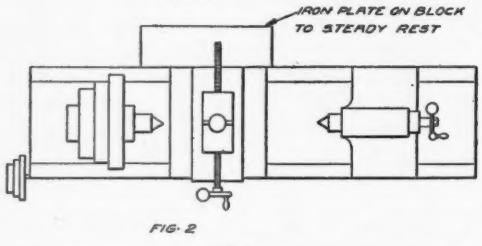


FIG. 2

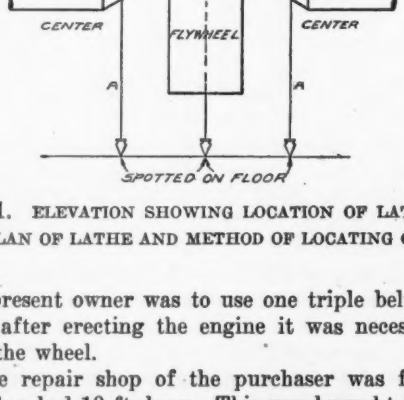


FIG. 1. ELEVATION SHOWING LOCATION OF LATHE
FIG. 2. PLAN OF LATHE AND METHOD OF LOCATING CENTERS

The present owner was to use one triple belt 76 in. wide, so after erecting the engine it was necessary to recrown the wheel.

In the repair shop of the purchaser was found a lathe with a bed 10 ft. long. This was brought into the engine room and set up on the floor stringers temporarily laid to receive it as shown in Fig. 1. These stringers were securely blocked underneath and braced from the engine foundation.

The 2 lathe centers were brought exactly in line by the use of a test bar in the ordinary way and the lathe so located that the 2 centers when at the extreme ends of the ways were lined up parallel to the crank shaft. A plumb line A, Fig. 2, was dropped from each center and spotted on the floor as shown.

Then the center of the width of the flywheel was marked in the face and also spotted on the floor.

The distance from the edge of the wheel to the center was noted in inches and using the usual rule for turning a taper the proper amount of setover for the lathe figured and with the aid of the spotted marks on the floor referred to, the one end of the lathe was thrown over as required.

A small engine was belted to the governor pulley on the crank shaft while a small motor was used to run the lathe. When the proper chip had been removed the other side of the face was treated in like manner and while a slow method it was the best way out of the job.

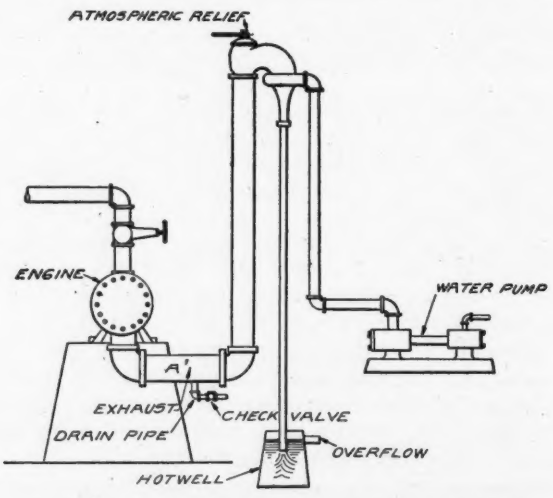
RECEIVER.

Auto-Drain for Barometric Condenser

IN A siphon condenser, we had a flat seated valve in the drain pipe, and sometimes when it was forgotten being left closed on shutting down, the condenser leg got filled with water. In winter, if the drain was forgotten, there was trouble next morning in thawing it out.

But we have "revised the old edition." We took out the valve and replaced it with a check. Now, when the vacuum starts to form, the flapper shuts and no further attention need be given as formerly. Upon starting up in the morning, I am sure the condenser or exhaust leg is free from water. Over night, condensate cannot accumulate in leg A; it automatically drains out through the check valve. It is 2 in. in diameter; I have seen drains of only an inch, which is too small.

LUKE MARIER.



LOCATION OF CHECK VALVE IN CONDENSER PIPING

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Refrigeration Questions

When the expansion coils of a refrigeration system are covered with frost from one end to the other, are we then obtaining the best possible results?

2. When the temperature of the gases are higher at one end than at the other of a double-acting compressor, which end is at fault? J. J.

ANSWERS

Frost on the outside of expansion coils is a very good insulator, and when the coils are well covered with a thick frost, the effectiveness of the coils is much reduced. The coils should be thoroughly defrosted at frequent intervals.

2. For the greatest capacity, a compressor should have the low-pressure, or inlet side, kept as high as possible, and the high-pressure, or outlet side, as low as possible. The low-pressure is, of course, governed by the temperatures which must be maintained in the refrigerating rooms, while the high-pressure is governed by the temperature of cooling water available.

The superheat of the ammonia gas during compression is reduced by water jacketing of the cylinder, and sometimes by injection of a small amount of liquid ammonia into the cylinder.

If one end of the compressor is showing a high temperature, that is the one usually at fault, and the cause of this high temperature should be sought and removed.

The discharge pressure from both ends must, of course, be the same, since both ends are discharging into the same outlet pipe to the condenser. The difficulty will, therefore, probably be a restriction in the flow of water through the water jacket, particularly if the cylinder head is water-jacketed; or if the cooling in the cylinder is done by the injection of the liquid ammonia, the amount of liquid being sent to the hot end of the cylinder is less than that sent to the cold end.

A. L. R.

Eccentric Identification

How can you tell the "forward" from the "backward" eccentric in a link motion or reversing engine, and does the direction in which the engine is going change the eccentric? Thus, while running over, the outside one might be the forward and in running under the inside one may be the forward eccentric. R. W. S.

A. There is no definite way of determining which eccentric is for the forward motion and which for the reverse, unless you are acquainted with the make of engine, and even then there is no hard and fast rule, as occasionally a manufacturer will be called upon to make an engine to meet certain operating conditions that will change the usual design.

To go back to the plain slide valve engine, the engine from which all others have been copied or improved upon, the eccentric leads the pin, no matter what the direction of rotation may be. If you see such an engine "running over," the eccentric is ahead of the crankpin; if "running under," the eccentric will lead the pin in that direction also.

When a link motion has been added to such an engine in order to convert it into a reversing engine, you have nothing more or less than an engine equipped with 2 eccentrics as cited above, one to function the valve while "running over," and one while "running under," only that instead of being attached directly to the valve stem they are attached to the opposite ends of the link, and a reverse lever added by means of which the link is thrown from one extreme end of its travel to the other, thus placing one or the other of the eccentrics in a position where it can function the valve, the other eccentric for the time being simply moving the long end of the link back and forth in a position where it has no bearing upon the action of the valve unless the link be "hooked up," as is the common practice on reversing engines operating continuously, such as locomotives, marine engines, or hoisting engines in mining service where the shaft is of considerable depth.

When we get away from the plain slide valve reversing engine with its direct motion, and take up engines of a more careful design, for service where steam consumption is of some importance, we come to some of the apparent complexities of design which have a great bearing on the location of the different eccentrics for the direction of rotation. The valve may have inside lead; that is, it may be of the piston type, admitting steam in the middle and exhausting at the ends, in which case the eccentric follows the pin and is in a position exactly opposite to that in which it would be if the steam were admitted at the ends of the valve. Then, suppose that an engine equipped with such a valve has a reversing rock shaft interposed between the eccentrics and the valve; then, in that case, the forward eccentric would lead the pin as in the plain slide valve instead of following it for the reason that the inside lead and the reversing rock shaft constitute negative qualities which bring the location of the forward eccentric back to the location where it would be if the motion between the eccentric and the valve, and the lead were both direct—that is, outside lead.

It is now apparent that there are so many mechanical complexities that intervene in the several makes of engines that no hard and fast rule can be laid down for determining which eccentric is for the forward motion; but there is this feature which is generally adopted by manufacturers of engines, tending to clarify

the matter somewhat; the eccentric which functions the valve for the direction in which the engine rotates the most or in which it carries the greater load (as, for instance, a locomotive pulling a train, or a hoisting engine pulling a load up only) is generally placed next to the bearing on the main shaft, and with the link in the position where it hangs naturally downward.

Suppose that a locomotive, for instance, in traveling forward, should use the eccentric which would require that the link be held up on the reverse lever gear; in case of an accident to the gear while the engine would be in motion, gravity would naturally reverse the engine under full steam, probably causing a disastrous wreck.

Still, the location of the forward eccentric next to the main bearing as generally practiced, is not a general rule seldom violated, as the demands of modern industry are so great and varied that engine builders must resort to all manner of schemes in designing engines to suit existing conditions.

In marine practice, you will generally find the valve gear so arranged that the links are at the rear of the engine as seen from the operating deck, when the engine is operating in the forward motion. On larger vessels equipped with reciprocating engines, where the operating deck is above the level of the eccentrics, this arrangement is not absolutely necessary, as the links would not necessarily interfere with the vision of the operator, as is the case where the operating deck is below the level of the eccentrics.

Owing to the lack of space around marine engines, however, the eccentrics are so arranged as to cause the least inconvenience to attendants when the engine is operating in the forward position. GEO. H. WALLACE.

Why the Drop of Pressure in Receiver?

TO WHAT would you attribute the cause of the receiver pressure of a cross-compound condensing engine dropping from 8 lb. to 5 in. of vacuum? Is this dangerous? What is the remedy?

2. What would you do should the condenser of a compound condensing engine stop with the throttle valve partly closed?

3. Why is it not allowable to use angle stays below tubes on return tubular boilers?

4. If, while engine is in service, you take cards and find a longer cutoff on one end than on the other, how would you determine without reference to the cards which end it was?

5. When reboring the cylinder of a large upright engine, at which end would you begin? Why?

A. E. E.

ANSWERS

IT IS a little difficult to tell, without an examination, just what would cause your receiver pressure to drop from 8 lb. to 5 in. of vacuum. Our first judgment would be that, for some reason, your low-pressure steam valves did not cut off as early as they should, possibly not at all, thus allowing the steam from the receiver to pass through the low-pressure cylinder without expansion.

Another cause may be that your steam valve in the low-pressure cylinder leaks badly, thus allowing steam to pass directly through the cylinder without doing any work. There is no particular danger in regard to this lowering of receiver pressure, except that your high-pressure cylinder is being overworked, but there is a great falling off in the amount of power that can be delivered from the engine.

2. When shutting down a compound condensing engine, you find the condenser suddenly stopped, your proper course will depend largely upon the type of condenser which you have and the conditions surrounding the engine. If the condenser is of the barometric or surface type, there is not much danger of the water being pulled over into the cylinder of the engine before it will stop, so you can go right ahead and shut the valve in the regular way. If, however, you have a jet condenser, you should make all haste to open the vacuum breaker so as not to pull the water back in the cylinder of the engine.

3. The bottom plate of a boiler shell is subject to a good deal of expansion and contraction, on account of its location next to the fire. It must, therefore, be free to come and go without hindrance that would result from staying the heads to it.

In the second place, in order to get rapid transfer of heat from shell to water, there must be rapid circulation of the water along the bottom of the boiler, and nothing should be put here which will interfere with this circulation as would a mass of braces connected to the shell.

In the third place, the sediment which may be thrown down from the water collects on the bottom of the shell and if there is a mass of obstruction, such as would result from the connection of braces, the scale would form around these and it would be almost impossible to remove it. Through the scale forming as it would around the connection of braces to the shell, would be a source of overheating of the plates, which would probably result in bagging at these points, also burning off of the rivet heads holding the braces.

4. We do not know of any way by which you can tell when one end of the cylinder is cut off earlier than the other, except possibly in an extreme case, without the use of an indicator, and even if you know that one end is cut off earlier than the other, it would be impossible to tell which end it was, while the engine is in operation, without referring to the indicator cards. Of course, by shutting down the engine and taking measurements, you will be able to get the information you desire.

5. In reboring a large upright engine cylinder, it would seem most practical to begin at the top, for two reasons: One, that you have more room to work in; second, that the chips when falling clear themselves of the boring machinery. R. E. T.

Factors Considered in Leakage Tests

WE HAVE been making some leakage tests in our plant and the question has arisen in my mind that if we should catch all of the discharge from the trap that bleeds the entire header, together with leakage from water column and blowoff, which includes all leaks in the plant, if this would not be an accurate determination of the plant leakage.

We have made several leakage tests by using the gage glasses on the boilers, but they all seem to be excessive and after careful checking, making the proper correction for the density of the water at the pressure, I am unable to locate the trouble. S. R. B.

A. If you are quite certain that the trap bleeding the main header, and the blowoff from water column and blowoff valves is all possible leakage, the test you outline would, of course, be accurate.

It must be certain, however, that there is no chance for leakage at flange joints in the supply pipes leading to or from the main header, or for drip carried away from separators at the engines or other machinery. You must be sure, also, that any water taken from the trap or blowoff under pressure is discharged into cold water tanks, as otherwise there will be a good deal of this water evaporated into steam when it is released to atmospheric pressure.

The check by the fall in the gage glass is, of course, a troublesome one to get with accuracy; but on general principles we should expect the error to be on the side of reducing the leakage rather than increasing it.

A. L. R

What Are "Universal Motors?

WILL YOU kindly explain the principle of the "universal" motor? Also, what changes are necessary whereby a direct-current fan motor may run on an alternating-current source of supply? P. J. B.

A. The term "universal" is applied to those motors which will operate either upon alternating current or direct current, either without any change whatever in the adjustment of the motor or with the addition of external resistance, or with one or both of these features. Such motors are necessarily series wound and possess a speed torque characteristic in general like that of a series-wound direct-current motor. Consequently, their application is limited to desk type of fans, blowers, washing machines, etc.

Your direct-current fan motor, if series-wound, should operate with alternating current of a similar voltage without any alteration. If shunt wound, a new winding will be needed on the fields.

Temperature Alarm for Cooling Water

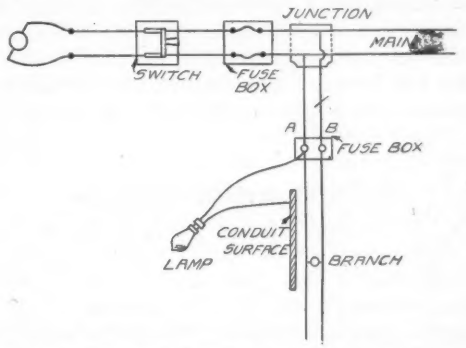
WE ARE OPERATING a crude oil engine and wish to make an automatic alarm to indicate when the cooling water reaches a temperature of about 150 deg. F. I would appreciate it very much if you would give me a suggestion as to how a simple and reliable electric alarm could be made. C. A. P.

A. We know of no home-made device which would give a reliable water temperature alarm. An installation of a Sarco Thermo switch with a bell battery in circuit, should give satisfaction in your case. This switch is actuated by the expansion and contraction of a heavy hydro-carbon oil in a brass tube, and adjustment may be made so that the switch may be thrown within a range of 2 deg. F. of a predetermined temperature.

Locating Grounds in Conduit

A GROUND DETECTOR indicates the presence of a ground on a lighting circuit, all of which is carried in conduit. Is there any method by which I can locate this ground or will it be necessary to pull the wires out of the conduit? A. L.

A. The lamp method is usually employed to locate a low-resistance ground. Locating a ground is largely a matter of elimination, and a systematic and thorough inspection of each branch should be made before any attempt is made to remove the wires from the conduit. It is customary to begin with the branch nearest the source and continue outward.



METHOD OF CONNECTING TEST LAMP TO LOCATE GROUND

One method of locating a ground in a conduit is by the application of a lamp test. Beginning at the fuse box just beyond the line switch, press one terminal of an ordinary incandescent lamp to the conduit surface and the other terminal to first one wire and then the other, and if the lamp lights the ground exists at some point beyond, on the wire which does not cause the lamp to light.

At the first junction box on the main line determine, as before, which wire is grounded. Take out the fuse in that wire and see if the ground disappears. If so, the ground is on the wire which was unfused. If the ground is not on that circuit, go on to the next and repeat the test until the grounded branch is found.

When the grounded branch is found and a thorough investigation of the outlet and junction box connections, wherever accessible, fails to disclose the fault, attention should be turned to the insulation and tests should be made to determine the approximate location of the break. To accomplish this, open up the line in the next to the last outlet or junction box, and repeat test for ground. If it still exists, the next section should be cut out in the same manner, and so on until the grounded section is located. The wires should then be pulled from this section of the conduit for examination. W. P.

Transformer Connections

IN HOOKING UP single-phase transformers on a single-phase primary and having a 3-wire 220-110-v. secondary with the transformers in parallel, can the neutrals be hooked together the same as the outer or 220-v. legs?

2. In using 2 single-phase transformers in open delta on a 3-phase primary and furnishing 220-v. 3-phase secondary also a 3-wire 220-110-v. secondary can the 2 neutrals be joined as one? Also, with this same primary and secondary only using 3 transformers in closed delta or star connected, can the 3 neutrals be joined together as one? C. D.

ANSWERS

WITH the outside leads of the 2 transformers properly connected with reference to their respective polarities, the neutrals may be connected and the 2 units operated in parallel. This method of connection, known as "banking" of transformer, is employed quite extensively.

2. In the case of single-phase transformers connected in open delta, closed delta or star, the neutrals cannot be connected as suggested for the reason that such a scheme would result in shortcircuiting sections of the various windings. The common points of connections of Y-connected transformers may, however, be connected together and form a common return for the other 3 lines. In this case, you would have a 3-phase 4-wire system.

O. H. H.

Boiler Operation Questions

WE HAVE a Scotch boiler which we use on Sunday only, while the others are being cleaned; the rest of the week this boiler is idle. How shall I leave it during the remaining 6 days? Should it be drained of all water or should I leave the water in? Would the latter method cause any damage?

2. I have considerable trouble with the dry pan of a Stirling water-tube boiler. This pan consists of a drum provided with 96 perforations which become so plugged up with dirt that I am compelled to clean them often. Would it be a good policy to re-drill these holes, making them ½ instead of ¼ in., as they now are?

Would larger holes tend to allow water to enter the main header when the boiler foams, as it does especially during the summer months, or on opening the main stop valve when connecting to the other boiler?

W. J. McK.

ANSWERS

IN VIEW OF the fact that you use your Scotch boiler every Sunday, we should recommend leaving it filled with water. No harm will result under these conditions, but the boiler should be filled clear full, not left with the water line standing part way up, as this would possibly cause some corrosion at the water line. After the boiler is out of service and pressure is down, fill it until water shows at the safety valve. It can then stand safely until wanted for the next week's run, when the extra water can be blown down.

2. In regard to the Stirling boiler, it would hardly be advisable to enlarge the holes. If these are clogging up with dirt, it shows that the dry pan is doing just what it is there for,—preventing this dirt from being carried over into the steam pipe,—and if you enlarge the holes, you simply permit this dirt, and also the particles of water, to carry on into the steam pipes more easily.

The thing to do in such a case is either strain the water before it goes into the boiler, so that the dirt will be removed, if it is floating dirt, or if it is chemicals thrown down in the boiler, put on a surface skimmer, which will carry away the sediment floating at the surface, and prevent it from being thrown up with the steam bubbles into the dry pan.

A. L. R.

WHICH IS the better in cleaning tubes, a dry brush or a steam jet? Why?

2. If you were in the engine room, how would you know the boilers were priming or foaming?

3. How would you set a valve that was controlled by a flywheel governor?

4. What is the object in placing try cocks on an angle in the head of a steam boiler?

5. If you opened a throttle or safety valve suddenly, what effect would it have on the water line?

W. J. McK.

ANSWERS

CLEANING TUBES with a jet of steam has these advantages over brush-cleaning: The soot is blown farther away from its point of accumulation on the tubes; the tubes may be cleaned while the boiler is in operation, and portions may be cleaned that are inaccessible with the brush.

2. Knocking of the engine, when not caused by faulty engine operation, may sometimes be considered as an indication that the boilers are foaming or priming, this metallic-sounding knock being caused by water carried over from the boilers with the steam. An excessive amount of water taken out by the separator at the engine would also be an indication.

3. The maximum travel of a valve controlled by a flywheel governor is fixed by the design and construction of the engine, so that in setting the valve, all that is necessary is to make sure that the valve travel is equalized so that the steam action will be equal at each end of the cylinder with the governor blocked out to give the cutoff with which the engine was designed to operate with the rated load. The exact method of setting the valve is dependent upon the make of engine and type of valve, but in general is the same as for a plain slide valve, first blocking the governor to running position, generally with cutoff at about ¼ stroke.

4. Try cocks are placed on an angle in order that when one cock is being blown it will not blow water upon the others or the gage glass.

5. Opening the throttle or safety valve suddenly, the water line will rise, owing to the release of the pressure above the water and expansion of steam bubbles forming in the water.

W. P.

Using Safety Valve as Relief Valve

CAN YOU use a pop safety valve for a water relief valve, and vice versa?

SUBSCRIBER.

A. A pop safety valve could be used for water relief, but is not desirable, since there is no reason for having any blow-back or drop in pressure. The water relief valve should open when the water pressure rises to a predetermined point, and close as soon as the pressure returns to that point. A relief valve cannot be used for a safety valve, first, because it is not made strong enough; second, because it has not the blow-back feature.

IN "RUSSIA," a journal published by R. Martens & Co., of New York City, two important subjects are discussed: The possibility of hydro-electric developments of which 13,000,000 hp. is still unused, located in the best industrial areas of the empire, and available for lighting, railways, industrial plants and electro-chemical operations; and the development of an area of 70,000 sq. mi. of oil fields in the Ural district which will replace the slowly diminishing supply in the Caucasus and Baku regions.

Construction of a Big Plant

(Continued from page 736)

enameled brick fronts at the end of the boilers. In the completed boilers there are 7-ton feed hoppers above the stoker hoppers shown, in order to carry a larger supply of coal directly at the boiler. In the construction of the furnace an arch is sprung in the side wall at each end, 9-ft. 3¼-in. span and 16½-in. rise to carry the weight of the brick walls above this point. This makes it possible to take down all fire brick lining below the arch and rebuild it as may be necessary without in any way disturbing the upper part of the boiler setting. The bridge wall is made with a curvature from front to back, the bottom part of the wall being 3 ft. thick and tapered upward to the point where it meets the tile roof.

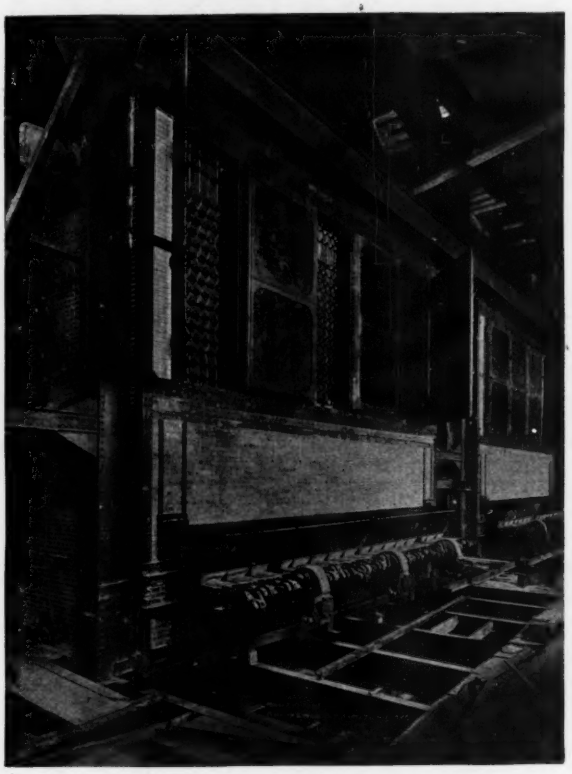


FIG. 18. BOILER FRONTS AND BRICKWORK

For cleaning the boilers, Vulcan Soot Blowers are installed, each having 8 stands of nozzles on each side of the boiler. They are of vertical blow type, the nozzles being arranged to be rotated by chains over sprocket wheels and extending down to the floor level. Each stand has its separate control valve and there is also a main control valve and drain to insure that all water shall be removed from the pipes before starting the blowing.

This blowing is done by steam taken from the superheater outlet through a 2-in. flange connection, this being one of the few installations where tube blowing is done with superheated steam. To insure continuous draining there is an automatic drain on the supply pipe to the soot blower and also there is a blowoff cock at the bottom of each stand pipe from which may be released any condensation which make take place in this stand pipe while the blower is out of use. To insure that moisture is kept out of the superheater header a ¾-in. drain is run from each header to the ashpit, but this would be used only when starting up a cold boiler.

Stokers installed are the Riley underfeed with inclined grates, 16 retorts being supplied for each boiler. The feeding plungers are driven from an eccentric shaft which in turn is driven through a countershaft in a trench below the floor in front of the boilers. This countershaft is driven in 4 sections from 4 12-hp. induction motors, set on platforms between the boilers at 7 ft. above the floor level. All of these are 4-speed motors and 2 of them are connected with the drive shaft through jackshafts, the other 2 through Reeves multiple speed drives which have a speed ratio of 3 to 1. This makes it possible to drive the main shaft at from 96 to 290 r.p.m. when driven through the jackshaft connection and at from 32 to 290 r.p.m. when driven

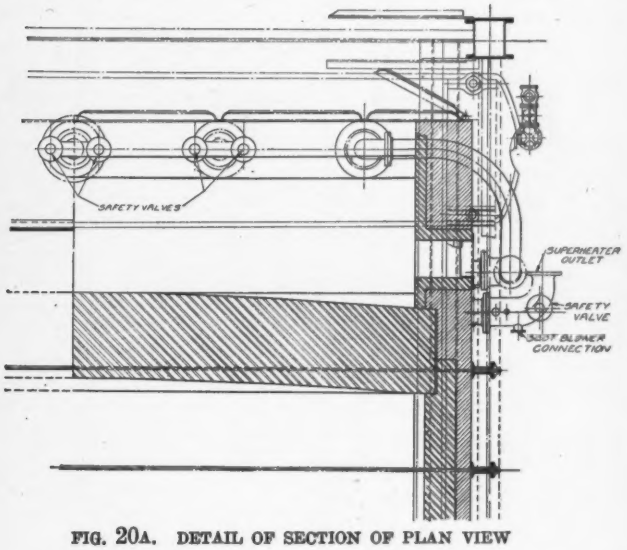


FIG. 20A. DETAIL OF SECTION OF PLAN VIEW

through the Reeves speed changing devices. The whole system is so connected that any stoker may be driven by any motor or each stoker may be driven by its own motor as circumstances require. It is calculated that with this variation in speed the coal feed can be varied from 1600 up to 15,000 lb. of coal per hr. per boiler, and it is intended that 2 of the boilers driven by the jackshaft connection will be used to take the steady load and the 2 boilers operated through the Reeves speed changing devices will be used to take fluctuations in load.

The boilers are set so that there is a distance of 11 ft. 9 in. from the ashpit floor to the bottoms of the headers at the front end, while the furnace is 8 ft. from grate to lower tubes, and 8 ft. 8 in. long. The inside of the furnace is 24 ft. 10 in. wide above the grate and is 25 ft. 6 in. wide at the stoker level. The thickness of the firebrick lining at the stoker level is 20 in., and above 24 in. The entire setting is firebrick lined, the brick in front of the furnace being 18 in. wide at the stoker level and stepped out 22½ in. at a point just

below the tubes. Side walls, roof and combustion chamber are also completely lined with fire brick, and the entire bridge wall is of firebrick construction.

STOKERS

As seen in Fig. 21, the bed of the Riley stoker consists of alternate retorts into which the coal is fed by horizontal plungers and perforated air plates forming the sides of the retorts, and which move back and forth to shift the fuel bed forward. As the coal reaches the ends of the retorts, it is carried forward by moving grate sections which extend the entire width of the furnace and eventually falls on to the dumping plate, where it is continually pushed forward by reciprocating pushers. The dumping plate consists of a series of hinged sections arranged so that more or less of these may be used as horizontal, the balance hanging down vertically at the end of the furnace, thus permitting of adjusting the opening through which the ashes fall to the hopper below. Thus, the entire surface of the stoker is movable and the entire dumping plate can be dropped downward

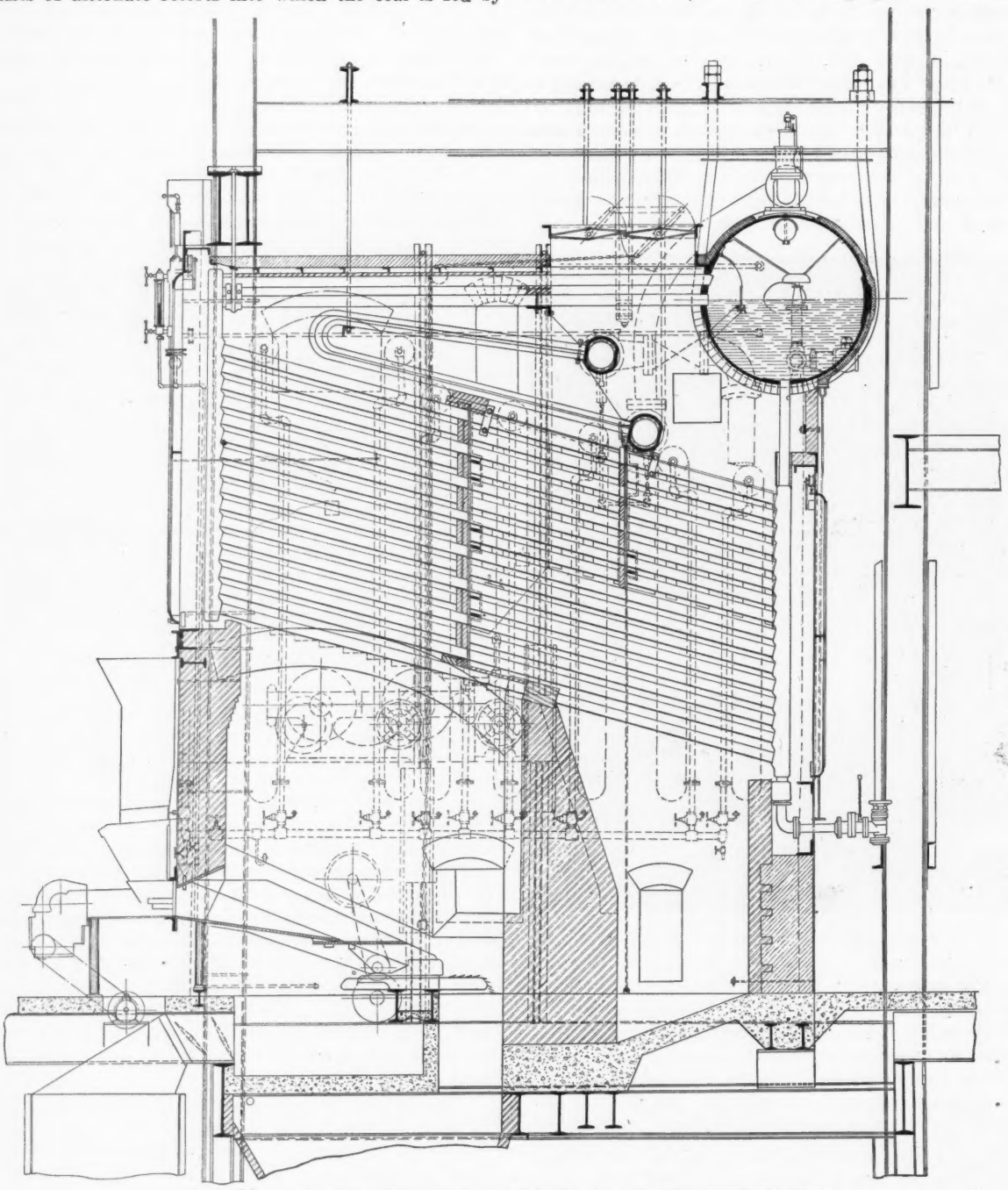


FIG. 19. SECTIONAL SIDE VIEW OF BOILER AND STOKER INSTALLATION

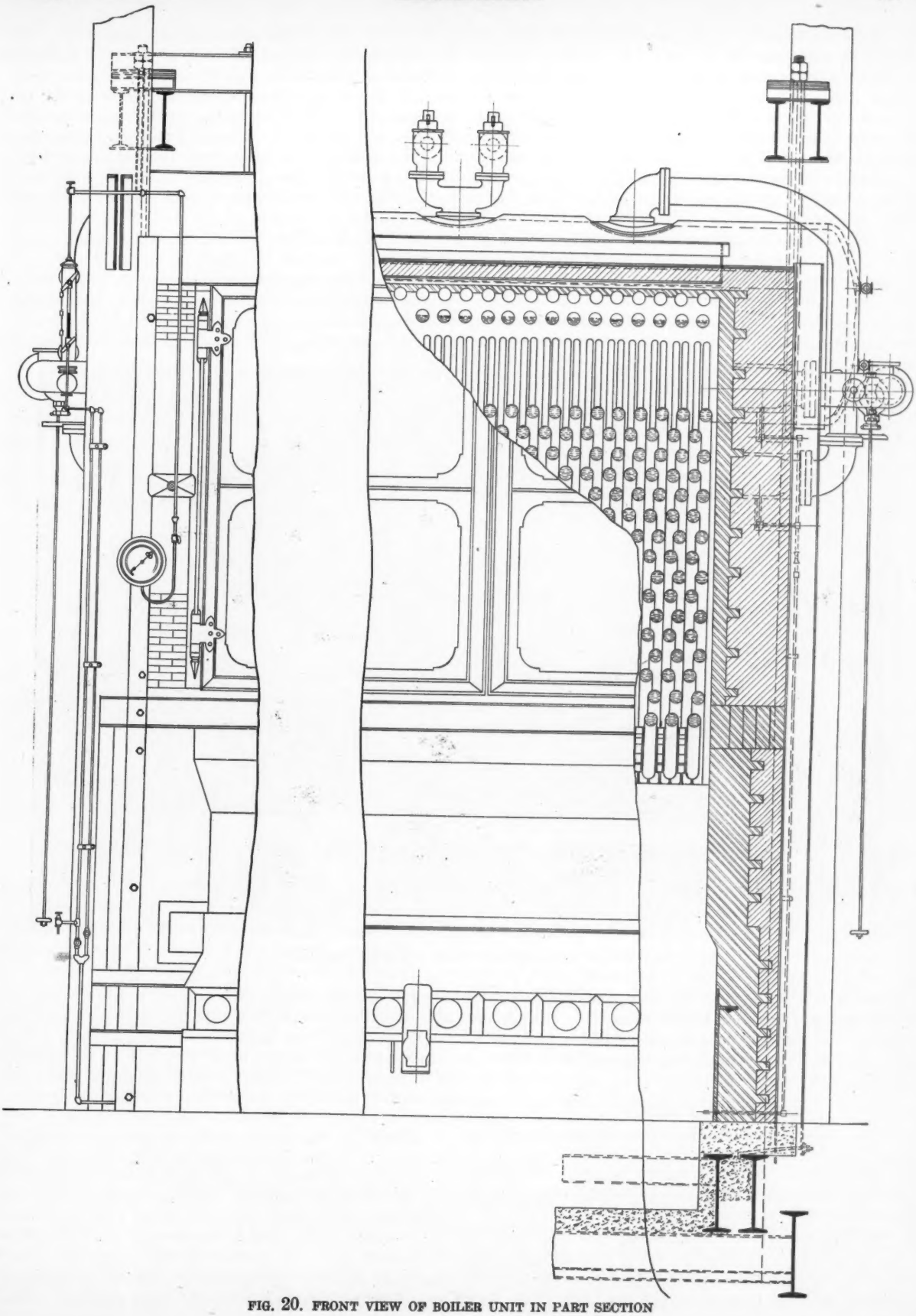


FIG. 20. FRONT VIEW OF BOILER UNIT IN PART SECTION

to relieve the furnace of any accumulation of ash and clinker at the lower end.

The plungers which feed the retorts are driven by cranks from the main shaft which, in turn, is driven by a double worm gearing from a lay shaft running in front of the stoker. The speed of this lay shaft may be regulated according to the load carried by the boiler, also the stroke of the plungers may be regulated by means of a lost motion device in the side rods which drive the plungers.

Position of the dumping plate is controlled by means of side bars operated by a ratchet and pinion from a hand wheel at the side of the boiler setting down at the lower lefthand corner of Fig. 18. The movable sections of grate are also operated from the main crank shaft of the stoker by cams located between the cranks which drive the retort plungers. These reciprocating grates are really hollow blocks, so that air is sent into the furnace through these blocks at the top and sides, yet fuel and ashes cannot sift through them into the air chamber below.

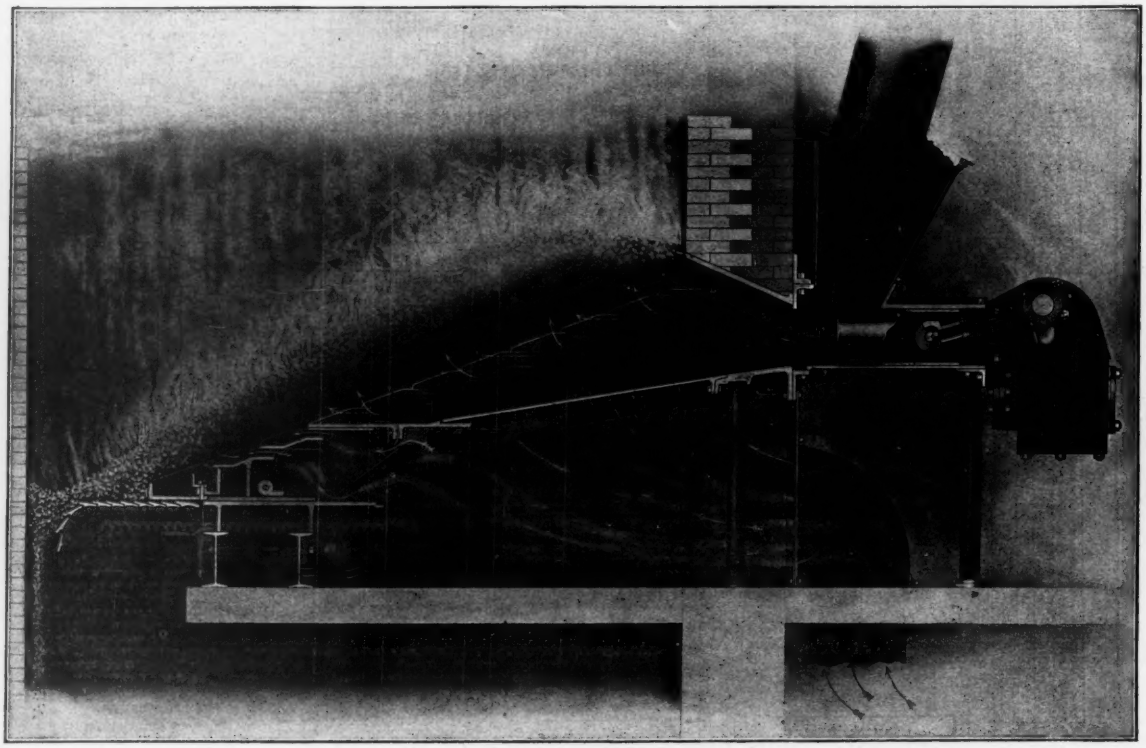


FIG. 21. SECTION OF RILEY UNDERFEED STOKER

Boiler Furnaces

THE POSITION of the reservoir hoppers above the regular stoker hoppers is shown in the cross-section drawing of the boilers, Fig. 19, which indicates also the double butterfly dampers installed in the uptake, which has an opening 4 ft. 6 in. by 24 ft. 10 in.

The roof over the furnace from the front baffle to the bridge wall consists of 2 rows of C brick, one facing upward, the other downward, divided by a row of plain brick to hold the C brick against the tubes. The front baffle plate is lined with 2 rows of fire brick, with ¼ in. of asbestos between, and in front of the rear baffle is a single row of fire brick, with asbestos between the brick and the flame plate. On top of the boiler a roof of C-shaped brick is laid above the top row of tubes and above these is a series of angle irons supporting the red brick roofing. The steam drum is covered with 2 in. of 85 per cent magnesia covering on the outside, and rests at the ends against an inverted arch of fire brick carried on the side walls.

Figure 19 shows also the connections from the steam drum to the water column, and the ⅜-in. blowoff and drip pipe which connects to the bottom of the water column and to the bottom of the gage glass, discharging into the ash pit. Below the floor level of the boiler room is a waste-coal pocket, which can be readily cleaned out into the ash cars in the basement, and at the rear of the stoker is a passage below the dump plates leading to an ash hopper, which has at the bottom clam shell valves to discharge into the ash cars. The floor of the combustion chamber is also sloped towards the bridge wall, and connection is made for removing the soot and ashes which may collect here by means of a hydraulic ejector.

Figure 19 also shows clearly the method of suspension of the boiler to the framing of the building, the location of the vertical stands for the soot blower and the control valves, and also the peek holes provided for inspecting the flame at different parts of the boiler setting. There is provision in the combustion chamber for a cleanout door, also in front of the bridge wall above the dead plates of the stokers, a door for breaking up any clinker which may form, and above the boiler tubes

back of the superheater for cleaning off tubes and for cleaning out the superheater tubes and headers.

Figure 20, which is a partial view from the front of the boiler, in section, shows the connections, the location of steam gage, the arrangement of the outlet from the superheater header, and the connection from the steam drum to the superheater inlet. It shows, also, the arrangement of the feed water piping, which is controlled by a 3-in. Schutte & Koerting check valve, a Hancock globe valve and an Edwards drum head stop and check valve with handle extending to the floor within easy reach of the boiler attendant. Between the boiler and the setting there is a space of from 1 to 2 in. allowed to take care of any shifting or expansion of the brickwork or the boiler structure, this space being tightly packed with asbestos.

Building Details

Figure 23, which shows the appearance of the plant in December, 1915, after current was being generated, indicates the style of architecture of the building, the position of the coal tower on the water front, the boiler house with the 2 stacks at the left, the turbine house in the center and the switch house at the right. All buildings are of red brick with limestone trimming and copper cornices of ornamental design, and would be creditable additions to the large public buildings of any city. Inside, the boiler room is finished in a smooth, gray brick, and the turbine room with a gray pressed brick having ornamental copper cornices and handsome torch lighting fixtures, the large windows being of ornamental design and the walls being set off with panels of white enameled brick, having green tile ornaments in the corners. The roofs in all cases are covered with 5-ply slag laid on concrete slab supported by the steel arch trusses, and with monitors at the center.

Reinforcement for the boiler room floor, which is 9 in. thick, consists of No. 1 rod, laid 2 in. on centers near the bottom, and of No. 7 rod, 12 in. centers, crossing these at right angles. The top of the floor is 1-in. granolithic finish. All windows and doors have steel casings and sash, the windows being filled with wired glass and pivoted to swing at the centers.

The concrete base for the walls, shown in Fig. 23, is 6 ft. 4 in. in height, and 24 to 28 in. thick, the brick wall rising above this in the boiler room to a height of 95 ft. 2¼ in. to the main roof, and 113 ft. to the top of the monitor. All stair wells are enclosed and provided with iron stairways. The height of the switch house is 94 ft. 6¾ in., the floors being from 7 to 10 in. thick of reinforced concrete. The floor of the battery room is 5⅝ in. thick, covered with sand and with 5-ply Hydrex felt, and above this, a layer of 4 in. of vitrified brick, the joints being ⅛ to ¼ in. thick and filled with Hydrex compound.

(To be continued in the Sept. 15 issue)

At the meeting of the Administrative Council of the American Uniform Boiler Law Society, held in New York on July 11, satisfactory progress was reported in regard to the dissemination of information as to the A. S. M. E. Boiler Code, the Administrative Council was continued with the same representatives from various sections, financial reports showed all bills paid and a comfortable balance on hand, and it was decided to put forth the strongest effort for the adoption of the Code in the states of Connecticut, Michigan, Illinois, Minnesota, Texas, Missouri, Tennessee, Louisiana, and to continue the effort in New York State.

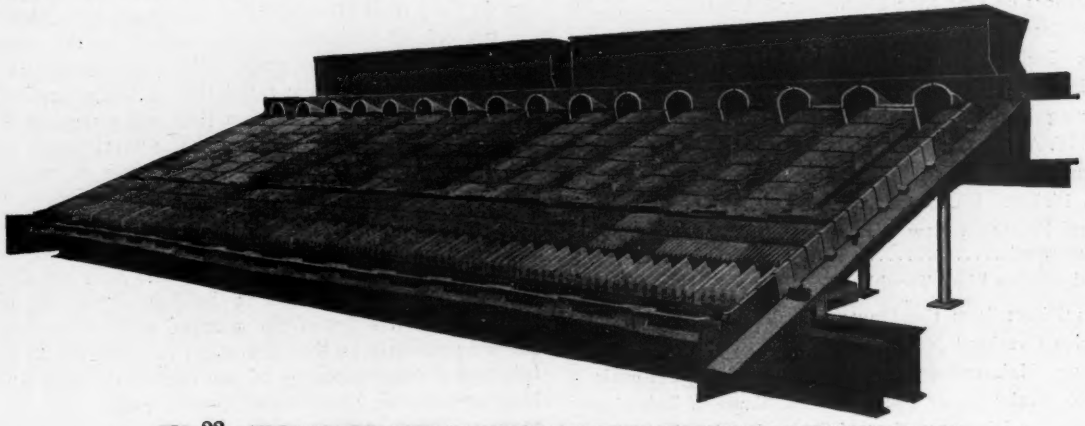


FIG. 22. SIDE AND REAR VIEW OF ONE OF THE RILEY STOKERS FOR THE ESSEX PLANT

The Uniform Boiler Law Society has received requests continually from all parts of the country for information concerning the A. S. M. E. Boiler Code, and desires and deserves earnest support for the coming year of all those interested in the betterment of boiler conditions. The funds of the Society are raised entirely by voluntary subscription, and the work carried on is that of endeavoring to secure the adoption of the Uniform Boiler Code by state legislatures and city councils. Further information can be obtained from Thomas E. Durban, Chairman of the Administrative Council, Erie, Pa.

In the Barometer number of the pamphlet published by the Taylor Instrument Companies, of Rochester, N. Y., a very interesting treatment is given of the weather variations over different parts of the earth's surface, and how the National Weather Bureaus of the different countries keep track of the weather and make predictions.

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Service Efficiency First

The sense of proportion is one of the most valuable possessions of the successful engineer, and knowing what is good enough for the purpose in hand marks the difference between the tyro and the expert in more cases than one. It is a singular thing, indeed, to find that now and then efficiency of power-plant operation must be sacrificed to service effectiveness, considering all that has been said about cutting the cost of operation per kilowatt-hour to the minimum within the capabilities of the staff and equipment.

An interesting example of putting service first occurs in the pumping installation of the New Orleans (La.) Sewerage and Water Board. At the main waterworks station of the city, a 6000-kw. turbo-generator is operated to supply electricity for motor-driven drainage and sewerage pumps. This unit has to be in service a large part of the time, New Orleans being a low-level city in comparison with the adjacent Mississippi River, and requiring an unusual amount of pumping in case of storms, and also in clear weather.

Now, since rainfalls and run-off, and the tide level outfall conditions at New Orleans, are not in the least influenced by the fact that the various pumping stations can do their most effective work at certain specified lifts, the problem of economical power supply is one of much interest. The time during which these stations are pumping at nearly their rated lifts is but a small fraction of the time during which they are pumping above or below their normal ratings. The vital point about the pumps is their ability to discharge a maximum amount of water with a minimum amount of power from the very start of a storm, regardless of the lift. Only a limited amount of power is available when a heavy rain begins, and this power must not only be able to produce maximum results in holding down the levels on the suction sides of the pumps, with a few pumps started promptly as they are required, in order to maintain the storage capacity of the canals as much and as long as possible, but it must also be possible to operate more and more pumps as the increasing run-off reaches the various stations.

The load on the turbine above mentioned is generally below 15 per cent of its most economical rating; but it has been found desirable to keep this unit in operation under this condition in order to meet the demands of the drainage system with a minimum of delay, allowing the pumps to be started before the crest of the drainage run-off reaches the stations. By this method, additional power is instantly available at all hours as rapidly as the load can be built up at the pumps, enabling the latter to give the maximum possible service in the effort to keep the drainage canals at all times below the theoretical flood limit. Additional boilers are then fired up and the remainder of the drainage and sewerage load taken on as soon as the boilers are cut into the line.

The steam economy of the turbine under such a load-factor is necessarily poor; but the total amount chargeable to its operation, maintenance and repairs, which figures below 5 mills per kilowatt-hour, is not considered excessive by the Board's engineers, and is justified for the improved service its constant operation is able to give.

Uniflow Engine Performance

Much interest is manifest in the performance of plants having Uniflow engines installed. Among the readers of Practical Engineer, there must be many who are operating such plants, and it will be a great service to fellow readers if some data in regard to the steam consumption, coal consumption and upkeep costs could be furnished by those having charge of such plants. It is not necessary that, in the publication of such statistics, the name or location of the plants should be given, but this should be known to the editors in order to establish the accuracy of the records and the local conditions of operation.

Installation costs for plants having Uniflow engines are also desirable, and we trust that readers having any such information will, in the interests of the profession at large and for the benefit of their fellow engineers, let us have all the information which they may have on hand along these lines.

Editorial Comments

In recent years, students of public need for electric light and power have, for the industrial and thickly populated sections of the country, decided in favor of systems of interconnected power plants. A plant of such a system is made the subject of the leading article for this issue. The importance of the plant, its size, equipment, construction, location and all are of such interest to power plant men that many of the details of building construction and erection as well as complete details of power generating equipment are given. The amount of information on this plant which has been prepared for readers has necessitated dividing the article, the second part of which will appear in the Sept. 15 issue. It is rare indeed that such complete and important information is available for publication and it is presented to readers as typical of the best modern design, equipment and construction.

In the fourth and last article of the series on Oil Fuel by Mr. Peabody which has been abstracted for our readers from proceedings of the International Engineering Congress, the most important phases of the subject, from an operating standpoint, are considered. There has been a great amount of experimenting with oil burning furnaces of different designs and proportions and in this article we get reliable data on the burning of oil which represents the best practice of today.

Modern power plants have floors built, quite generally, of reinforced concrete and to keep floors under boiler furnaces from deteriorating has been a serious problem. In the article on Insulation of Fire Boxes on Concrete Floors we present a method which has thus far proved successful.

Unfortunately 2 motors cannot always be used to drive the same line shaft and divide the load proportionately, but fair success has been obtained in some instances as noted in an article by Mr. Hull in this issue.

As a communicator of information the electric circuit reigns supreme, and Mr. Sitton tells us how his motor speaks when out of "juice."

Upon the excitation of the generator depends the reliability of the plant, it must not fail. Considering not only reliability, but economy, the duplex exciter sets described in this issue represent an advance in power plant equipment well worth considering in any large plant.

Distribution of boiler scale deposit in water-tube boilers has always been more or less of a guess just because nobody took the trouble to investigate. One engineer, however, gives us some interesting figures in the article entitled Scale in Water-Tube Boilers.

A little lawn around a power plant kept well trimmed and watered and a small bed of flowers are invariably the reflections of the man's mind who planned and keeps them. Inside that plant, we have, no doubt, the same neatness and order prevails, for the same mind is at work. Mr. Allison has a good idea for the lawn.

Coming to us from abroad are some interesting results of tests of autogenous welting as conducted by the Swiss Federal Testing Laboratory. The deductions should be of value in this country. Mr. Blakey also gives other developments and discoveries which are valuable.

In his second article on Practical Points on Raw Water Ice, Mr. Solomon gives a detailed description of the ice tank and how it should be cared for, just such information that will help you in your everyday work.

What may happen when something is neglected is told by Mr. Thurston, yet neglect and oversight seem to be the rule in many plants.

Direct from the plant, we have some letters describing installation, construction, maintenance and repair. The overhead shaft offers some puzzling erecting problems, Receiver solves one for us. Your pump, do you treat it right? C. H. W. tells you how. Other letters also give valuable experiences.

To the handy man with an inventive trend we present some ideas in the Kinks Department that can be put to use in any plant. Can you imagine anything simpler for filtering oil than is described here?

Practical questions fully answered, was the idea followed out in selecting the questions and answers for publication in this issue. They are all important questions and their value to you depends upon where you work, but you certainly will receive value from some of them.

For increasing the efficiency of power plants we describe a newly developed under-feed stoker, a boiler feeder system and the use of a boiler coating, all of which have a place in small plants as well as large.

News, catalog and trade notes published in this issue should not be overlooked, for they present opportunities which you cannot well afford to lose.

THE FIRST 6 mo. of 1916 in the iron industry showed a continuation of the highly prosperous conditions that prevailed during the last 4 or 5 mo. of 1915, according to E. F. Burchard of the United States Geological Survey. In fact, activity was even greater in 1916 than in the first half of 1915. Large increases are shown in the output of both iron ore and pig iron. The shipments of ore from the Lake Superior region during the first 5 mo. of 1916 were more than 10,000,000 gross tons, or 83 per cent greater than those of the corresponding period of 1915.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Stevens' Under-feed Stoker

ENGINEERS of small-capacity steam plants should be interested in increased boiler efficiency and capacity, in the elimination of smoke, in reduced fuel bills, in the economical burning of low-grade fuel, and in the maintenance of an even furnace temperature. All of these features, together with simplicity in design and construction and small maintenance expense, are claimed for Stevens' Under-feed Stokers, made by the Nelson Blower & Furnace Co., of Boston, Mass.

This stoker comprises a trough or troughs open at the top and extending from a short distance outside of the front of the boiler to the rear of the fire box under the boiler. In the bottom of each trough is an inter-

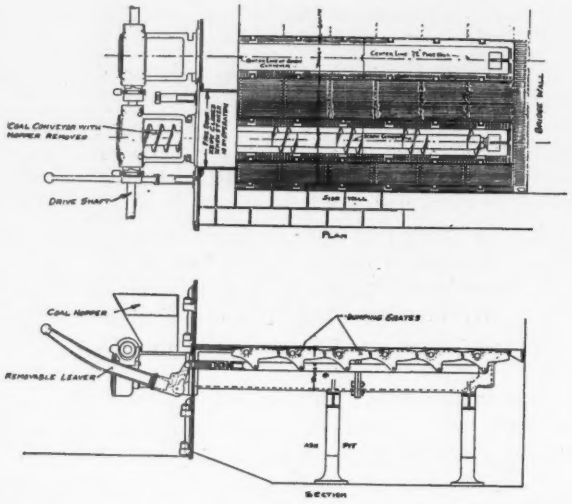


FIG. 1. PLAN AND ELEVATION OF STEVENS' UNDER-FEED STOKER

mittent screw conveyor driven from outside the boiler in a simple and efficient manner, and so constructed that it is possible to spread coal to a level depth as required over the entire grate area. Grates of a special rocking and dumping type adapted to give an exceptionally wide opening when dumped, are placed on each side of these troughs and approximately level with the top of them. All the grates between any 2 troughs are connected to form a section, which is independently controlled, enabling the fireman to clean each section readily.

A removable hopper is fitted to the outer end of these troughs, into which the fuel may be dumped by pipe conveyor or shovel. The stoker for each boiler can be independently driven by a motor or steam engine or can be coupled to other stokers or moving elements as may be desired. A turbine or any other type of blower can be used for forced draft.

The stoker is built to fit in between the side walls and bridge walls, stands on legs and has its own front, which, in case of a water-tube boiler would be new from the floor to the joint just above the fire-door arches, and in a return-tubular boiler to the line opposite the center of the boiler or wherever the dividing line comes in the

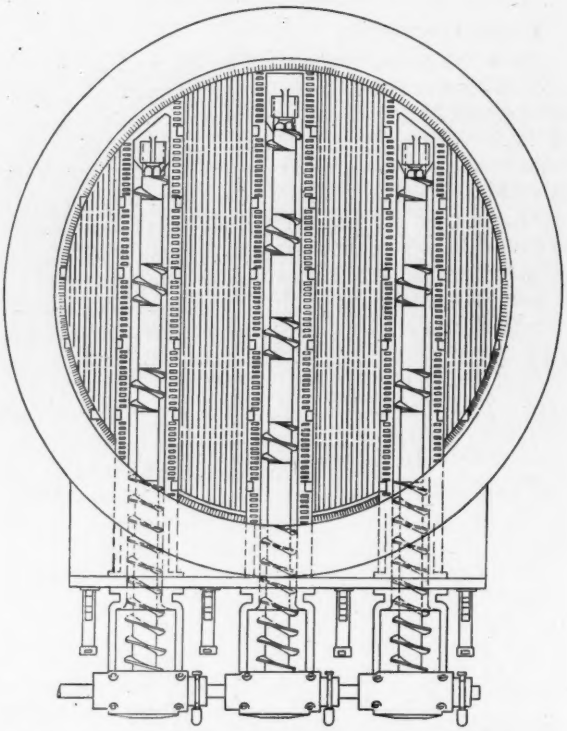


FIG. 2. PLAN OF STEVENS' UNDER-FEED STOKER AS USED UNDER MANNING BOILERS

boiler front. These boiler fronts have their own fire doors, ashpit doors and leveling doors, the latter just above the fuel hopper. The fire doors enable one to bank the fires at night, during the noon hour or for any other period the same as a hand-fired furnace. Fire-door arches and fire-door liners are the same as in a hand-fired furnace. In case of a breakdown to stoker or stoker drive, the boiler may be continued in operation by simply removing the fuel hopper and handling as a hand-fired furnace. The ashpit doors are the same as in a hand-fired furnace, thus allowing one to clean out ashes and refuse easily and quickly and also to use doors for natural draft.

This stoker, which has a minimum number of inexpensive parts subject to repair and no moving parts in the fire, has no special setting or coking arches to burn out. The dead plate, the fire-door arches and the fire-door liners are practically the same as those used in any ordinary furnace. When forced-draft equipment is supplied by the manufacturers, a turbine under-grate blower is used and installed between the ashpit doors. This enables one to install the blower without removing a brick or doing any excavating whatever. A high ashpit pressure is not required.

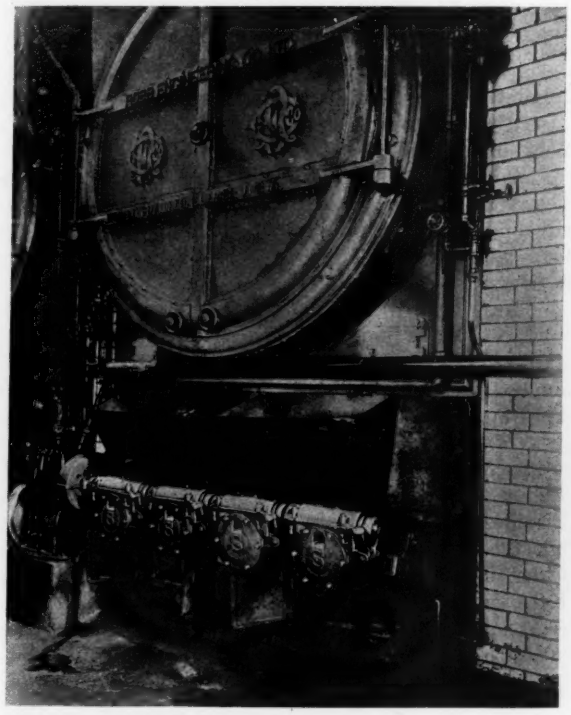


FIG. 3. A TYPICAL STEVENS' UNDER-FEED STOKER INSTALLATION

The Stevens' Under-feed Stoker does not push the fuel into a heap and allow it to tumble to the 4 sides of the fire box, or use moving grates to push the coal towards the rear or sides of the furnace. The feeding is done on the intermittent worm, which is in the bottom of each fuel retort. There are no tuyere openings in the fuel retort, air being supplied in the ashpit under the whole grate area on the ashpit side.

This stoker is adapted to fit under water-tube, horizontal return tubular, 2 or 3-flue type, Manning and other upright boilers having a setting which it is possible to go through, brickwork or an iron base. It can be installed in from 2 to 3 days, or over Sunday if necessary, and takes up but 24 in. of space in front of the boiler.

W. P. LYONS, formerly of the Lyons Boiler Wks., has joined the sales staff of the H. W. Johns-Manville Co. as a special representative and will devote his entire time to the sale in the Chicago district of J-M Steam Traps and J-M High Temperature Cement.

Boiler Feeder System

THE Southern Building, one of the largest and leading office buildings in Washington, D. C., is equipped with the Farnsworth Duplex Boiler Feeder system of handling condensation from a low-pressure heating system with vacuum return valves on each radiator, which has eliminated electric driven vacuum pumps by separating the air off to the sewer and feeding the water into the boiler automatically.

The condition involved in this building was that they have 2 150-hp. boilers which are operated on 1 to 5 lb. of steam pressure to supply the radiators throughout the buildings. Each radiator is provided with a vacuum return line system valve, and the electric-driven vacuum pump was designed to pull a vacuum on return lines. Motors in connection with these belt-driven vacuum pumps were 2 15-hp., pulling all air and condensation from the radiators and discharging both into a high

FARNSWORTH DUPLEX BOILER FEEDER SYSTEM

column or tank which separated the air to the atmosphere, and as the water was at a sufficient height in this stand pipe, the condensation flowed by gravity back into the boiler.

Handling this air and condensation was expensive, as the electric current had to be purchased from the central power station, hence, the pumps were shut down, the condensation and air allowed to flow away into the sewer, and water to replace this condensation was taken from the street main, at an average temperature of 60 deg. F.

This was a loss possibly greater than the cost of operating the pump, but the methods seemed to give better satisfaction than when the electric pump was in operation.

A Farnsworth Duplex Boiler Feeder was installed as shown in the upper right hand corner above the boilers. This apparatus has a duplex receiving and delivering chamber which provides air separation, as one chamber of the apparatus is always open to receive the

condensation and separate off the air to the sewer, while the opposite chamber is under pressure feeding water into the boiler.

Alternate filling and emptying of these chambers oscillates the tank back and forth which operates the control valves; in the operation of these control valves the air vent valves are always open on one chamber or the other, depending upon which way the tank is tilted; therefore, the condensation and air from the heating system flow into the boiler feeder as freely as they would flow into the sewer, and the condensation is fed into the boiler automatically. By this installation the Southern Building has made a large saving in its coal bill, for the reason that the condensation and make up water is now being fed into the boiler at a temperature of about 212 deg. instead of at 60 deg.

J-M Airtite Boiler Wall Coating

NECESSITY for an easily applied coating to prevent air infiltration through a boiler setting was brought about by the growing realization that imperfect combustion, with its corresponding heat loss, is often due to air leaking into the boiler furnace. Each crack and crevice in the boiler setting allows air leakage so that air mixes with the flue gases before perfect combustion takes place, and prevents their giving up the maximum number of heat units. Not only this, but the air which leaks in is cold and uses up heat units which should be developing steam. The result is decreased boiler efficiency.

J-M Aertite Boiler Wall Coating, made by the H. W. Johns-Manville Co., applied to the outside of the boiler wall, is claimed to eliminate entirely air infiltration. It provides a tough, rubbery coating or blanket over the entire boiler setting, which remains tight on account of its adhesive and ductile qualities. It is easily applied by troweling on the outside of boiler walls, and best results are obtained by keeping the thickness as near 1/16 in. as possible.

The quantity required to cover 100 sq. ft. depends upon the number and variety of cracks and the way the wall has been pointed up. For 1/16 in. thickness it will take approximately 25 to 40 lb. per 100 sq. ft.

Results obtained in a large New York power plant indicate the efficiency of Aertite. Before application, a test for CO_2 back of the first baffle wall showed 13.5 per cent, and back of the second baffle 11.6 per cent. After Aertite was applied, the corresponding percentages were 13.8 and 13.5, showing the stoppage of important leakage between the first and second baffle walls.

News Notes

DR. A. N. TALBOT, Professor of Municipal and Sanitary Engineering, in charge of theoretical and applied mechanics at the University of Illinois, who last year was honored by the University of Pennsylvania with the degree of Doctor of Science, has this year been made the recipient of the degree of Doctor of Engineering by the University of Michigan. The circumstances attending the bestowal of this honor by the University of Michigan are unusually complimentary to Dr. Talbot. It is stated that the university has but rarely conferred the doctorate in engineering, and never before upon one who is not an alumnus of the institution.

ON ACCOUNT OF difficulties in securing the use of the Armory building for the exhibit at Minneapolis convention, the exhibits will be arranged in the Pence Automobile Warehouse, 8th Ave. North and Washington, and the convention hall will be located on the second floor of the same building. Also Field Day at South St. Paul has been changed, and the sports will be held at the City Parade Playground, at 2 o'clock on Thursday, Sept. 14. This change is made on account of the time required to reach the South St. Paul grounds.

THE THOS. P. FORD CO., New York, announces the appointment of Henry Dusenbery as sales engineer for "Ford" steam and water valve specialties in the New York district, to succeed F. J. Miller, resigned.

Mr. Dusenbery is equipped with a technical education as a mechanical engineer, and in addition has the advantage of 7 yr. selling experience in the New York field with representative firms dealing in mechanical devices.

THE MOORE STEAM TURBINE CORPORATION of Wellsville, N. Y., has been organized with an authorized capitalization of $160,000.00, to build an improved type of single and multistage steam turbine in sizes from 5 to 1000 hp. The officers of the corporation, who are all men of long experience in the steam turbine business, are as follows: J. L. Moore, President, formerly Chief Engineer of the Kerr Turbine Co.; J. B. Laird, Vice-President, formerly Factory Manager of the Kerr Turbine Co.; E. D. Spicer, Secretary and Treasurer, formerly Chief Draftsman and Acting Chief Engineer of the Kerr Turbine Co. Plans have been drawn and the contract let for a modern brick and steel factory building, 90 by 140 ft., power house, and testing plant.

THE CONTRACT for furnishing the necessary equipment for the electric propulsion of the U. S. S. "Tennessee," the superdreadnaught of the largest and finest class, now under construction, has been awarded to the Westinghouse Electric & Mfg. Co. of East Pittsburgh, Pa.

The system of propulsion being installed differs from any now in use in battleships. Instead of the propellers being mechanically connected to the driving engines or turbines, there are 2 steam turbines developing over 33,000 hp. driving electric generators which furnish current to 4 6700-hp. motors, each motor driving a propeller.

Electric drive for battleships has been adopted after a careful investigation by the Navy Department to whom it presented numerous features of structural, operating, and military advantage, among which are that the steam turbines developing the electric energy may be located in any desired portion of the ship, that the propelling machinery may be better protected from injury, that full power may be available for reversing, and that greater rapidity in maneuvering is made possible compared with existing mechanical systems of control.

In addition to the main generating equipment and propelling motors, the contract includes the auxiliaries for the main turbine generator sets and smaller aux-

iliary turbine generators supplying light and power throughout the ship. The "Tennessee" will have several hundred electric motors for doing nearly all the work on board, from raising the anchor to steering. Electricity will also be used for cooking, ice making, refrigeration, and numerous other purposes. In all, 37,500 hp. of electricity will be needed, the amount required for a city of about 100,000 inhabitants.

U. S. CIVIL SERVICE COMMISSION announces an examination for mechanician and laboratory assistant, Sept. 20 and 21, to fill a vacancy at $3.50 a day, in the Bureau of Mines, San Francisco, Cal. Applicants must have reached their twenty-first but not their fortieth birthday on the date of the examination, and must submit to the examiner their photographs, taken within 2 yr. Apply for Form 1312.

Books and Catalogs

HOW TO BUILD UP FURNACE EFFICIENCY, by Jos. W. Hays; 154 pages, illustrated; tenth edition; Chicago, 1916. Price, $1.00.

Since the appearance of the last edition of this book previous editions of which have already been reviewed in these pages, it has been published in Great Britain and Norway and translations are now being made preliminary to its publication in the Spanish language. With the present edition the book has reached its fiftieth thousand.

Except for some few changes in the text and some added illustrations and an appendix devoted to the subject of the combustion of oil, gas, wood refuse and other fuels, the present edition differs but little from the last one.

THE ISSUE of The Monad, the official organ of the American Association of Engineers, for July and August, contains interesting articles on the work of the Association, the part which the engineer should take in political affairs to advance his own interests, and the news of Association doings. The office is at 29 S. La Salle St., Chicago.

VEEDOL, the title of a book issued by the Pratt & Washburn Refining Co., of New York, gives little indication of the fund of information on lubrication of gas engines of all sorts to be found within its covers. The sub-title is, Lubrication of Internal Combustion Motors, and it deals with the method of refining oils, testing of oils for various properties which influence their lubricating value, the method of operation of internal combustion engines, systems of lubrication of automobiles, motor boat, tractor and stationary engines, and the grades of oil best suited for use at all points in such engines. It is a book well worth careful study by anyone who has to do with combustion motors.

FROM THE ELLIOTT CO., of Pittsburgh, Pa., has been received Bulletin F, describing Welderon receiver separators, which are made for both vertical and horizontal pipe runs and for angle connection in several types which are fully described in the bulletin. The separation of water from the steam is accomplished by changing the direction of the steam current and slowing down the velocity, the moisture dropping to the bottom of the separator, out of the path of the steam, and baffle plates being provided to prevent creeping of moisture into the outlet. The receiver chamber is made in either riveted or welded construction or both, but the interior parts of the separator are welded to the chamber, and the flanges are screwed onto the inlet pipes and then welded in place. Copy of the bulletin may be had from the manufacturers.

A REVISED LIST of prices of the product of the Link-Belt Co., book No. 275, effective July 15, 1916, has just been received and gives a complete list of the chain, sprockets, gears and other parts of conveying systems manufactured by that company. It can be had from any of the offices of the Link-Belt Co., the main offices being in Philadelphia, Chicago and Indianapolis.

THE 1-5 ELECTRIC HOIST, designed for handling small loads with safety and economy, is the subject of an illustrated descriptive bulletin recently received. This hoist admirably serves the purpose of handling loads up to 500 lb. and can be operated to advantage over lathes, planers, boring mills, drill presses, etc.

Copies of the bulletin will be sent on request by Sprague Electric Works of General Electric Co., New York.

Trade Notes

LINK-BELT CO., 39th St. and Stewart Ave., Chicago, is enlarging its malleable foundry at Indianapolis in order to meet the increased demand for Link-Belt. The foundry extension will be a 1-story building, 70 by 275 ft., with a wing 105 by 140 ft. It will house the company's fifth melting furnace and will provide space for 60 molders. Contracts have all been let.

BECAUSE OF large increase in business, the Burt Mfg. Co., of Akron, O., finds it necessary to enlarge its manufacturing facilities, and is building 2 large 2-story additions to its already large plant. In the past, Burt Mfg. Co. has devoted its efforts exclusively to the manufacture and sale of oil filters, exhaust heads and ventilators, but in future, will add a general line of sheet metal work, which will require much new machinery that has already been ordered.

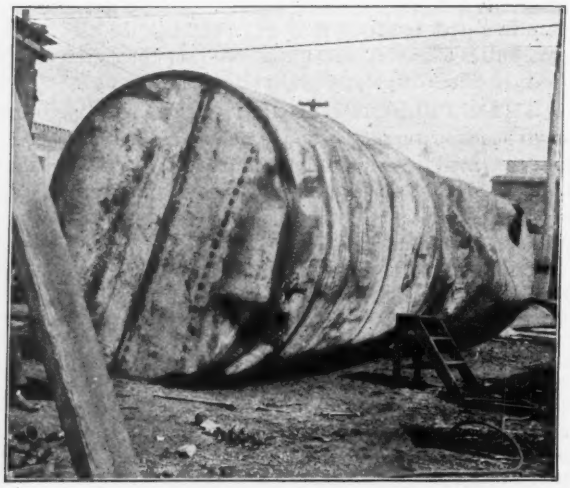
AMONG THE NUMBER of orders for turbines of large capacity received by the Westinghouse Electric & Mfg. Co., is an order from the Narragansett Electric & Lighting Co. of South Providence, R. I., for 1 45,000-kw. turbo-generator unit complete with condensers and all auxiliary apparatus. The Westinghouse Co. has also sold one 2500-kw. synchronous booster rotary converter with transformers and switchboard equipment to the same company.

The Westinghouse Electric & Mfg. Co. has sold to the Commonwealth Edison Co., of Chicago, 2 4000-kw., 25-cycle rotary converters for railway work; 2 4400-kw. 60-cycle synchronous booster rotary converters for lighting service, and 2 4200-kv.a., 3-phase transformers, 12,000-v. high tension a combination of water and self cooled according to the design of the engineers of the Commonwealth Edison Co. On this order there were also 1 2000-kw. 60-cycle, synchronous booster rotary converter, 1 2200-kv.a., transformer and current limiting reactances for generator and feeder leads.

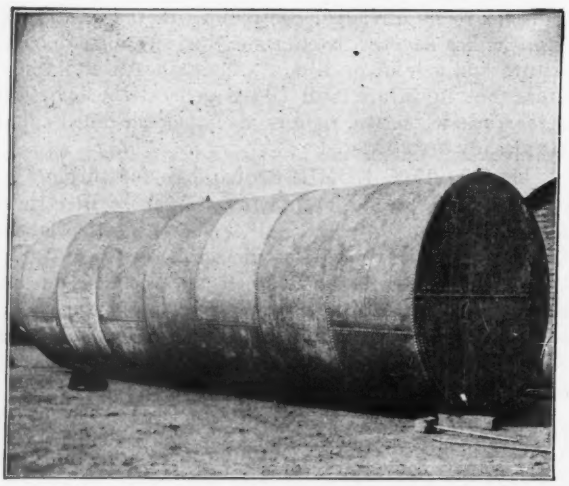
The Westinghouse Electric & Mfg. Co. has sold to the Public Service Co. of Northern Illinois, for its Branden

Bridge power plant at Joliet, Ill., 3 3000-kv.a., single-phase transformers, 2 9000-kv.a. 3-phase transformers and a complete power house switchboard to control 1 10,000-kw. turbo generator unit, transformers and feeders.

ANOTHER TRIUMPH was recently added to the many already credited to the mechanical engineering profession when the Johnson & Barry Steel Co., North Birmingham, Ala., accomplished the almost impossible by restoring 12 large oil tanks, 30 ft. long and 10 ft.



in diameter, belonging to the Texas Oil Co., to their former career of usefulness. These tanks were a mass of burned and melted iron, full of great holes, burst by various explosions during a recent fire. With a "Chicago Pneumatic" Boyer hammer, the tanks were com-



pletely cut apart and straightened out. All rivets were removed by Boyer rivet busters and the plates were riveted with Boyer riveting hammers. New iron was used, of course, to mend the spots where the iron was bursted out. Little Giant air drills were also used on this job, and a "Chicago Pneumatic" compressor supplied all the air used. The "before" and "after" photographs shown herewith will illustrate what a difficult task it was and how successfully it was completed.

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537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—As manager or chief engineer; 26 years experience with steam and electrical equipments, accustomed to the economical management of power plants and their maintenance; erecting engineering experience, good all around mechanic and electrician; age 46, married, strictly sober; best of reference; correspondence solicited. Address Leonard Miller, 100 Greenleaf St., Brownwood, Texas.

9-1-1

POSITION WANTED—Chief engineer in a small plant or operator in a large; 12 years' practical experience with steam, electric, refrigerating, pumping and condensing equipment. Technical education. First-class license and references; married; age 31; employed. Practical Engineer, Box 434, Chicago, Ill. 8-15-1

POSITION WANTED—License chief engineer wants change; 12 years' experience in manufacturing and central stations; steam, electric, refrigeration and producer gas; high speed and Corliss engines, condensers, etc. Age 32; American, and married. Address Box 437, Practical Engineer, Chicago, Ill. 8-1-2

POSITION WANTED—Young, sober and reliable married man, as engineer. Six years' experience with a.c. and d.c. compression ice plants, Corliss, high speed and slide valve engines. Ambitious. Desire change where advancement is possible. Open October 1st. R. Bruce, Caruthersville, Mo. 8-15-1

POSITION WANTED—By chief engineer, 35, married. Use no liquor; 15 years' experience, electrical and refrigeration. Wants position where ability and push will count. Can get results if given opportunity. Practical Engineer, Box 436, Chicago, Ill. 8-1-2

POSITION WANTED—As engineer in pumping station or some stationary plant. Ten years' experience. Capable of taking charge of plant. For further particulars address Engineer, 64 Lawrence St., Hartford, Conn. 8-15-1

POSITION WANTED—Young man, age 26, would like a position as helper in engine room where good advancement is assured. Am I.C.S. student. Will send information. Box 429, Practical Engineer, Chicago. 8-15-1

POSITION WANTED—As chief engineer. Am qualified to take full charge of power plant, a.c. or d.c., also refrigeration. Age 30; married; employed. Chicago only. Address Practical Engineer, Box 421, Chicago, Ill. 8-1-2

WANTED—Position as engineer in pumping station or in some stationary plant. I have had 4 years' experience in engineering. What have you to offer? E. W. Adkins, Charleston, Ill. 8-15-1

POSITION WANTED—Young man wants position as helper and extra engineer in steam plant for a start. Other particulars answered by letters. Write to W. D. Bellesfield, Rock Valley, Iowa. 8-1-2

Help Wanted

WANTED—Young Man for Assistant Engineer in medium sized Packing House, to keep records, drafting, tests, etc., some knowledge of theory desirable. Good opportunity for I. C. S. student. Address Practical Engineer, Box No. 445, Chicago, Ill. 9-1-4

WANTED—Large packing house requires services capable Master Mechanic. Permanent position. Excellent opportunity for high class engineer. Address Practical Engineer, Box 446, Chicago, Ill. 9-1-2

WANTED—A-1 Practical Engineer for large State Institution. Salary $100 per month and house rent. Permanent position. Address Practical Engineer, Box 447, Chicago, Ill. 9-1-1

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago. tf.

HELP WANTED—A resourceful mechanical designer to improve and simplify the construction of a motor driven agricultural implement. Three months' work. Salary and contingent fee. Answer by mail only. Theo. H. Price, 15 Wall St., New York.

Wanted

AGENTS WANTED for a power plant specialty. Territory east of Philadelphia not available. Merit of apparatus assured beyond a doubt. Our proposition to agents exceedingly attractive. Flynn & Emrich Co., Baltimore, Md. 9-1-4

WANTED—Agents handling Engine and Boiler Room Specialties to add side line paying big commissions. No samples to carry. Give experience, lines handled and territory covered. Address John L. Kneisly, 59 Green Street, Dayton, Ohio. 9-1-3

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

For Sale

FOR SALE—14x36 E. P. Allis Corliss engine, 100 hp., 100 r.p.m., cylinder re-bored, thoroughly overhauled one year ago; was good as new. Dubuque Brewing & Malting Co., Dubuque, Ia. tf.

Patents and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

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Sparks From The Advertising Pages

The useful arts, says Logging, are those requiring the skill of an artisan, and God help that artisan who rejects business as unbeautifully beneath him!

If business—the beautiful kind of business—is not an Art, then is there no art in all the world!

But, to be good Art, business *must* be beautiful.

It must forget the centuries of mean, grasping selfishness which brought it into disrepute among the better breeds of the past. It must realize that the art of business is the art of *living* and that no nation shall ever know wider or more beautiful life than that brought to it by and in its business.

One-half of the world's wakeful time is spent in business; the other half is bid for by other business which applies itself to man's recreational needs.

All business may be divided into these two parts—the business of supplying necessities and the business of providing luxuries.

Taken together, in proportions accorded to the earning capacity of individuals, these two make up the entire art of living to ninety-nine per cent of all humanity.

The one per cent is made up of "artists" who are working only for each other's appreciation, subordinating all wider appeal to technical niceties which none but fellow-adepts may even apperceive.

And so, if there is to be beauty in the world, business must bring it to us and must teach us how to see it; because nothing is beautiful to one who cannot perceive its beauty.

The beginning of beauty is in education which gives us eyes to see and ears to hear it.

And education when undertaken by business with the intention that it shall be applied to definite ends instead of as a mere "brain-developer" is a deliberate attempt to make people apperceive the beauty in some skillful adaptation of means to an end.

Simply, sincerely, forcefully—through the medium of pictures and words, business brings them to see the beauty in an idea and to *want* the thing's self.

And the name they give to this business-breeding invocation to the innate spirit of the good, the true and the beautiful, is Advertising.

Modern advertising, the spokesman of modern business, is also an Art: *must* be, if it is to remain true to that which it mirrors.

In fact, advertising is the one art which twentieth century civilization has mixed for itself. All others were poured from the past—readimixed.

Man never *creates* in the true sense of the word.

He merely mixes in new combinations, or re-groups concepts to form new ideas.

And so the new art of advertising is a mixture of nearly all the old arts, but fused to a single purpose.

Nor is it a mere evolution in painting and literature; for although it makes use of these, it makes use also of music and sculpture, of science in all its branches, of history and of the mechanical arts.

It is the voice of business, which is the art of living; and so among Arts it might well adopt the same motto which its birthplace has adopted among nations, "E pluribus unum" from many to one.